THE

ELECTRICAL REVIEW.

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THE

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RECENT DEVELOPMENTS IN ELECTRIC TRACTION.

ON July 13th a very interesting high pressure alternating power plant, worked by the water of the American River, was put into operation at Sacramento, California. The power-house is situated 23 miles from the nearest sub-station in the town of Sacramento. The plant consists of four 1,000 horse-power generators running at 800 volts. Step-up transformers raise the pressure to 11,000 volts, at which the power is transmitted over the line. At the sub-station at Sacramento, part of this power is transformed by rotary transformers to 550 volts continuous current, which supplies the entire tramway system of Sacramento, as well as a great part of the electric lighting of the city. We refer to this at greater length on page 270.

Besides this plant, another similar installation is employed to operate the power and lighting systems of Portland, Oregon. The generators are wound for 6,000 volts, and the power is transmitted from a distance of 20 miles. A sub-station is located at Portland, in which the alternating current is divided up and transformed for lighting, power, and traction purposes.

There is no reason why available water power at far greater distance should not be utilised and transmitted in this way.

Besides the two water-power plants mentioned above, steam-power plants are also utilised in the same fashion for feeding long lines. As an example, that of Lowell, U.S.A., may be given.

The main power-house there contains four 150 horse-power generators, part of which supply direct current to the line, and part of which supply three-phase alternating currents which are transformed up to 5,000 volts, and transformed down in two sub-stations, located respectively 7 and 15 miles from the power-house. 30-kilowatt step-up and step-down transformers are employed. Two rotary 100 horse-power converters are used in each sub-station.

There is at present under construction a similar installation of very great interest at Dublin, which is being put in by the British Thomson-Houston Company, Limited. This line extends from the City of Dublin through Pembroke and Blackrock to Dalkey, the total length being appproximately 8½ miles. Owing to the fact that the position of the power-house had, for various reasons, to be fixed near the beginning of the line, and in order to decrease the cost of feeders and return circuit, it was decided to feed the line near the station directly by continuous current, and to establish two sub-stations, one 3½ miles, and the other 8 miles from the power-house, to which three-phase alternating current, at a pressure of 3,000 volts, should be transmitted. In each sub-station two 60-kilowatt rotary transformers transform the alternating current into continuous current at 500 volts, and feed the overhead line. The machinery, as

well as the general installation for this line, is designed by Mr. H. F. Parshall, of the General Electric Company of America, and technical adviser to the British Thomson-Houston, Limited.

The application of electric traction to tramways being now universal in the United States, American railroad companies are beginning to see the advantages of employing electric power on their branch lines. By its use they are enabled to multiply the number of trains without materially increasing operating expenses. Thus the New York, New Haven and Hartford Railroad has just introduced the trolley on its Nantasket branch. This line has already been described in the ELECTRICAL REVIEW.

The Pennsylvania Railroad Company, one of the largest railway companies in the world, is now engaged in equipping one of its branches, about 8 miles in length, with the trolley system, and it seems highly probable that within the next two or three years, most, if not all, of the smaller branch lines of the large American railway companies will be operated electrically.

The solution of the "light railway" question in Great Britain would seem to lie in the construction of trolley lines similar in most points to these American branch railways. Instances beyond number are already to be quoted of advantageous results obtained by the introduction of such lines running either along the highways or on their own land. That steam cannot possibly compete on equal terms would seem to be fully demonstrated.

THE PRESERVATION OF TIMBER.

IN an interesting article our contemporary, the *Engineer*, considers the question of the preservation of timber. Practically but four methods of preserving timber have had anything like success, viz, Boucherising, Burnettising, Kyanising, and Creosoting, the four processes consisting respectively of injecting sulphate of copper, chloride of zinc, chloride of mercury, and creosote. The latter, in this country at least, has been the only one which has proved practically successful. Soon after the transfer of the telegraphs to the State, the Post Office largely used the first-named process, but at the present time it is doubtful if there are any poles existing which have been preserved (?) by the method. Boucherising had the one advantage, that poles submitted to the process could, if necessary (a rare necessity), be painted; but, as a preservative process, it was a failure. It seems possible that the position of the timber, *i.e.*, with the sap tubes vertical, may have had something to do with the matter, though we are not aware whether timber arranged horizontally has fared better. The chloride of zinc process served no better purpose, and the Kyanising treatment, even if it might have proved more effectual, was too expensive to be practical. Creosoting, so far, has ousted all competitors, and has proved distinctly successful when properly done. As regards the latter observation, we may mention that we have known a case in which, from imperfect creosoting, the heart of a pole has rotted, and could be pushed out, leaving a perfect creosoted tube.

As the *Engineer* points out, as long as creosote remains in the wood, decay is arrested; if oozing and displacement take place, decay will follow. Does it follow, however, that oozing must take place? The facts are that creosoted telegraph poles have lasted the best part of half a century, and buried creosoted planks have shown a similar preservation. In this case either oozing has *not* taken place, or the fluid portion of the creosote, if absent, has left some solid, or semi-solid, residuum, which has arrested decay. The ideal method, according to the *Engineer*, would be to fill the sap tubes with solid paraffin wax, provided the cost of such a process did not render it prohibitive. Col. Haskins's process, of which something is being heard, consists of subjecting the timber in the green state to the action of heated air under pressure; this process resulting, it is claimed, in a certain amount of destructive distillation in the wood, and the formation of a creosote product, and also in a jelly-like body, which imprisons that part of the sap which may not have been expelled. The *Engineer* points out several strong objections to the feasibility of the theory of the process, and although we cannot say that there is nothing in Col. Haskins's idea, we have strong doubts of it, and should prefer to wait for a quarter of a century before allowing ourselves to be convinced. There is, as we have more than once argued, no brief substitute for a time test.

Electric Lighting of a Great City.

SIR DAVID SALOMONS, in a recent interview, throws some curious side lights upon the operation of the company he is so closely connected with, which go to show that very radical changes in the design and construction of the Bankside Works are going on, and still more radical changes may be expected. First, he is now convinced that continuous currents are preferable, and he prophesies the almost immediate total disappearance of alternating currents for electric lighting. But here an "if" comes in, and it is an "if" of a large order. The alternating current will be abandoned "if" a perfect high tension continuous current dynamo and an improved continuous current transformer are forthcoming. Sir David has only to seek and he can find such machines, although at present they are not quite "fashionable," but it is not a very agreeable thing for the shareholders in the City of London Company to contemplate the abandonment of the costly alternating current plant on which they were asked to place their faith for something which may or may not answer the same purpose equally well. He frankly states his reasons for preferring the drum armature in an alternator to the disc, as it permits of end play and requires no special thrust bearings, and the disc armature with air cores has not sufficient self-protective self-induction; this objection is, however, not founded on good grounds, for if self-induction is of such importance it can easily be provided, even in an air cored disc armature. If the drum type of armature for alternators is to become general, plenty of them are to be had from native manufacturers; their construction is open to all, and their design exceedingly simple and easy. We believe the experience at Bankside points to the fact that, despite the extensive adoption of alternating machinery, we have not yet arrived at finality in the design of large alternators. Another feature of Bankside experience seems to be the abandoning of the pillar type of switching machinery and the substitution of open front connected switchboards. It has been said that experience keeps a dear school, but in the case of Sir David an exception has been made if we take seriously his reasons of joining the city company. He says he joined it "to gain experience with alternating currents used on a large scale." Few men can secure an appointment first and gain the necessary experience to fill it afterwards; however, Sir David is getting the latter and so far the company appears to be flourishing, although to this point and others we shall probably return next week.

Electric Traction at the Railway Congress.

Electric traction received comparatively comprehensive (if perhaps not quite correct or modern), treatment during the late Railway Congress. It is evident that a body of European engineers who devote their entire attention to the successful operation of great steam railways, are unlikely to be fully conversant with work done in an entirely different field, the more so when the chief examples are to be found not in Europe, but in America. That the subject should receive their attention at all, is, however, proof that they consider it an important factor in the future. If that inference be correct it is a great pity that so important a body as the International Railway Congress, should not have called upon some specialist who had devoted himself to this important subject to read a paper at its meetings, or at least to take part in discussion. The "report" on "The General Question of Electric Traction," is deplorably weak and has extremely little of interest to commend it to the serious attention of railway engineers, beyond the very ample discussion of the "Heilmann" locomotive. Historically it is fairly complete, but we cannot see great advantage in again publishing matter of no present practical value and which is already at the disposition of those to whom it may be of interest. In connection with the double trolley, ancient history only is referred to and nothing is said of the extensive system now in operation in Cincinnati. Much space is given to describing double reduction and chain gear, both of which have been discarded, and are out of date. No mention is made of recent successful applications of high tension alternating currents transmitted from long distances and transformed at sub-stations to continuous currents. A line on which this system has been adopted will soon be running at Dublin, and there are several such successfully operated in the United States. It would seem to us that some detailed mention should have been made of such interesting applications as the Baltimore and Ohio Railway's electric locomotives, the Elevated Railway at Chicago, and the proposed adoption of electricity by the Manhattan Elevated Railway of New York. It is erroneously stated that series parallel control cannot be used on electric locomotives of large power. It is precisely this method which has been successfully employed by the General Electric Company of America, in the electric locomotives which they have built for the Baltimore and Ohio Railway Company, and which pull trains of over 200 tons at 40 miles an hour. The general tone of the report is decidedly favourable to elevated conductors. It is stated that the conduit system, besides being extremely difficult to construct, has not given good results in practice, and has generally been abandoned after trials of short duration. Great trouble has evidently been taken in compiling the report and we can only regret that modern data regarding working expenses, coal consumption, &c., should not have been given in extenso. However disappointing the report may be, it is nevertheless a good sign that the subject should have received some attention during the deliberations of the Congress, and we trust that in another year, it will be more thoroughly and practically treated.

Electrical Communication between Lightship and Shore.

The lengthy letter which we published last week on this subject from Mr. H. Benest contains a few inaccuracies, which we are sure he will be glad to have pointed out, and some expressions of opinion with which we differ. Referring to the establishment of communication with the Needles Lighthouse in 1893, by Messrs. Smith & Granville, Mr. Benest says:—"These trials were not successful." This is not correct. We are informed that the experiment was made to satisfy the Royal Commissioners of the utility of the system by a practical trial. The Needles was selected not because it was a case which presented insurmountable difficulties to the establishment of communication by the ordinary submarine cable, but because it presented many of the features of an isolated rock lighthouse with none of the disadvantages of inaccessibility, &c. The experiment was so far successful that, as soon as money was at hand, the system was adopted for the case of the Fastnet Rock, and the importance of communication with the Needles Lighthouse being recognised, an ordinary telegraph cable was laid to it. As to our remarks about the probable movement over the bottom of a slack ring of cable laid round a lightship as in the system proposed by Mr. Evershed, we do not see that this has any bearing in the case of the Smith & Granville system. The cable laid from Galley Cove, near Crookhaven, runs direct to a position off the Fastnet Rock, and here terminates in a copper mushroom placed in 15 fathoms of water, and therefore out of any danger of damage from seas. This cable is not a light one, but of the ordinary type, and there is certainly no slack near the mushroom to be affected by tides and currents. The result of the costly experiments made by the Telegraph Construction and Maintenance Company some six years ago at the Fastnet, was that the part of the cable most likely to be damaged was found to be just a little below low water mark, and cutting out an ample margin of cable on each side of this spot certainly seems to be a most effective way of getting over the difficulty. As to whether a telephone or a mirror speaking instrument is best as a receiver on board a lightship, we cannot agree with Mr. Benest that the former is a *sine quâ non*. It is certainly the better, but experience has proved that lightship men take kindly to the system of visual signals, from its similarity to the ordinary flag signalling, which forms part of their training. If Mr. Benest means the telephone as a receiver of Morse signals, then we unhesitatingly pronounce in favour of the mirror, because, in addition to the point already mentioned as an advantage, any number of men can read the signals at the same time. To this Mr. Benest would probably add that each man could be supplied with a telephonic receiver; but such a course would not be likely. As to the utilisation of the lightship's chain as being better than an actual break in the circuit, which was originally suggested by Mr. Benest, in his paper read at St. James's Hall in March, 1892, we should be glad to know whether any experiments have been made in this direction. *Apropos* of the Smith and Granville system, it has been pointed out that in speaking of it favourably, and of Prof. Blake's unfavourably, we have been contradictory; but this is not so, and we shall probably deal with both these patents in a future issue, for, although at a casual glance they appear almost identical, the points of difference are very marked.

The "New" Electrical Engineer.

Ironmongery says:—"We have frequently, and even quite recently, urged in the most earnest manner the great importance of the trade paying special attention to electrical matters, and studying to cultivate what, efficiently managed, will assuredly prove to be one of the most profitable special branches of business ever touched. Moreover, it is a growing business, the prospects of which are roseate indeed, and in most pleasing contrast to those branches which have remained stagnant for years past, and which, to a considerable extent, seem to have had the best of their days. As we told the ironmongers, years ago, that they must become the cycle agents of the future, so we say to them now, that in the majority of localities they must become the electricians of the future, and that they never have yet touched a speciality which offers them brighter or more certain prospects of excellent business and large profits; while besides the paying work of fitting installations in private houses, business premises, churches and chapels, and other institutions, there is an accompanying trade in electrical supplies, which also is remunerative." . . . "Of course, this work is one which entails, as we very recently pointed out, exceptional knowledge, training, and ability. Given the latter, the first two can be acquired by every ironmonger who determines to adopt the trade, and none need fear failure if the efforts be intelligently directed, and the necessary hard work and zeal be put into the preliminary studies." If the intelligent ironmonger is to be the electrical engineer of the future what is to become of "Our boys"? Fancy our technical colleges shut up during the day, and depending upon evening classes of middle-aged vendors of hardware goods, each individual striving to arrive at a formula which, rightly applied, will show the way to a large profit on wiring.

RAILWAY SPEEDS.

The recent acceleration of the rival Scotch railway services has produced nothing very remarkable in the way of speed, the chief thing noticeable being the high mean velocity attained, and the excellent work done up-hill; but maximum speeds have been, we had almost said, moderate, and we question if anything in the running of either of the two services would be found to be better than what we experienced on the Midland Railway between Hellifield and Skipton on August 14th last, or than what may be any day experienced between Sheffield and Derby on the Midland Railway, which has apparently foresworn high mean speeds in its Scotch traffic. If the railway races teach anything, it is that we should look with suspicion on any claims for high speeds of 150 miles per hour, not that these velocities are dangerous, for in speed itself there is no danger. A curious feature in the race is that the West Coast companies seemed determined to win, even if they had to cut down their trains to a very small weight indeed, while on the East Coast the trains seemed to have been usually heavier, in the ratio of 179 to 112 tons, and to have been handled by single engines of the type specially English, which have done better work than any coupled locomotive ever built, and for a coal consumption far less than that of coupled engines. The chairman of the North-Western Railway, Lord Stalbridge, denies that they were racing; but he is, of course, a railway director, and is allowed to make statements in opposition to fact, that in other people would be looked on as lapses from accuracy. The public will not be slow to learn that in their general treatment by the railways they are being ill served, and cannot but perceive that the halting, shuffling progression of so many trains is due simply to lack of endeavour to be even reasonably or approximately punctual. If a mean speed of 54 miles per hour can be made for 540 miles as Mr. Marten says in the *Engineer* has been attained or exceeded more than once, and, indeed, has been increased to over 60 miles since penning this, we have a right to expect that trains scheduled at mean speeds of 20 miles should be run more to time. It is clear that main line steam traction will be hard to beat, but any further acceleration will now need to come out of improved maximum speed, and engineers would have looked with interest to the continuance of the race to see if any additional speed could have been forced out of the locomotive with present train loads. But as the racing has now been abandoned, we need say but little more upon a subject which does not appear to have caught the popular fancy. It is not a little curious to note how compound engines step to one side as soon as racing commences. It looks very much as though the locomotive was not a fit machine to run well if compounded; and, so far, the simplest engines built have shown the best results in fuel economy. Is the fault in the compounding, or is it in the use of the large low pressure cylinder which we have heard blamed for the apparent inability of compound locomotives to compete with simple ones. In America, where they use compound locomotives so much, they appear to have avoided large cylinders, and to have used two low pressure cylinders, and we think they are right in this.

ARMATURES AND MAGNET COILS.

By CLAUDE W. HILL.

(Concluded from page 227.)

The Magnetic Circuit.—Fig. 6. For the purpose of expediting the calculation of magnet windings, the writer has devised and patented the slide rule shown in fig. 7. The rule has three scales, A, B, and C; A represents ampère turns, B the length of magnetic circuit, and C the magnetic density per unit of sectional area. Scales A and C are fixed, and B is the slider. To determine the ampère turns required for a given magnet, the arrow head on scale B is brought opposite the required density on scale C, and opposite the length of magnetic circuit on scale B will be found the correct ampère turns on scale A. Thus, in fig. 7, the arrow head is opposite 80,000 per square inch density, and for a length of magnetic circuit of 60 inches there are required 910 ampère turns.

The scale C may be made detachable and a set of C scales may be kept, divided for different materials such as cast-iron, wrought-iron, and the various makes of special steel, dowels being fitted on the slide rule, and the C scales having corresponding holes to insure their being placed in the correct position. The writer has used one of these slide rules (a home-made one) for the last eighteen months or so, and has found it a great assistance.

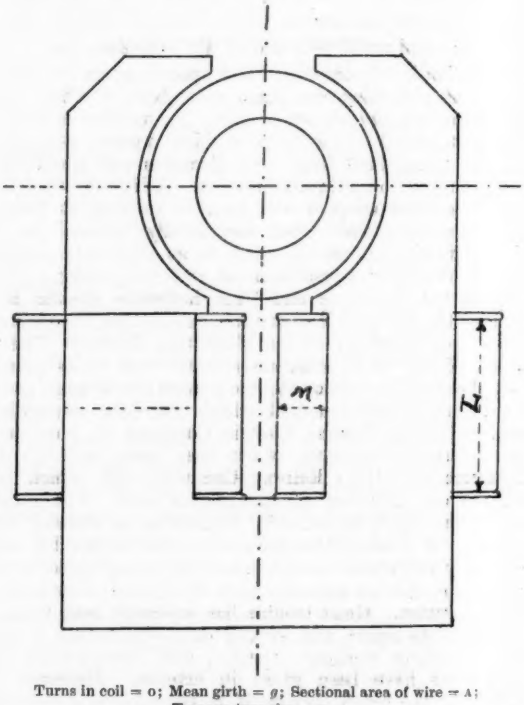
In shunt coils the ampère turns are determined by the diameter of the wire, and are practically independent of its length. It is therefore customary to settle a diameter of wire suitable for the ampère turns and voltage, and to put on as much length as will fill up the space provided for the coil.

The size of the shunt wire is given by the formula :—

$$d = \sqrt{\frac{\cdot 0000008602 \times \left(1 + \frac{T \times \cdot 388}{100}\right) \times a \times g}{E}} \qquad (4)$$

in which a = ampère turns, g = mean girth in inches, and E = volts across coil.

In series coils, the length (*i.e.*, number of turns) is determined by the ampère turns, and the diameter of wire has to be such as will fill the space.



Turns in coil = O; Mean girth = g; Sectional area of wire = A; Temperature rise = T.

Fig. 6.

The diameter may be found by the following formulæ :—

$$\text{Total turns} = \frac{\text{ampère turn}}{\text{ampéres}} = O.$$

$$\text{Turns per layer} = \sqrt{\frac{O \times L}{M}}. \qquad (5)$$

The dimensions of the space provided for the coil being known, the size of wire can now be determined.

The resistance of any coil at 15° C. is

$$R = \frac{\cdot 0000006756 \times O \times g}{A} \qquad (6)$$

For any armature it is

$$R = \frac{\cdot 0000006756 \times \text{convolutions} \times \text{length of 1 convolution}}{\text{current paths}^2 \times \text{area of conductor}} \qquad (7)$$

Weight of wire in pounds in a coil or armature

$$= \cdot 3213 \times \text{total length} \times \text{area of wire}. \qquad (8)$$

In designing dynamos it is usual to make the dimensions of the magnet coils proportional to the general dimensions of

the machine, and, consequently, the temperature rise is much greater in the small machines than in the larger ones. In a range of dynamos designed in strict linear proportion, the ampère turns required would be proportional to the lengths of the magnet coils, and it can be shown by the following formulæ that for an equal rise of temperature throughout the set the magnets must all have the same depth of winding, thus if the largest machine requires a depth of winding of 3 inches, the smallest machine will also require a depth of 3 inches. Of course nobody nowadays does design dynamos in strict linear proportion, but it is a useful fact to remember for it demonstrates one reason why it is impracticable to do so, for in a set of dynamos designed in strict proportion, if we arrange the largest to have a comfortable rise of temperature the smallest one may get red hot. It has been found that the rise of temperature of a magnet coil under ordinary conditions is 1° Centigrade for every ·0182 watt per square inch,* the surface of the winding only being taken. On this

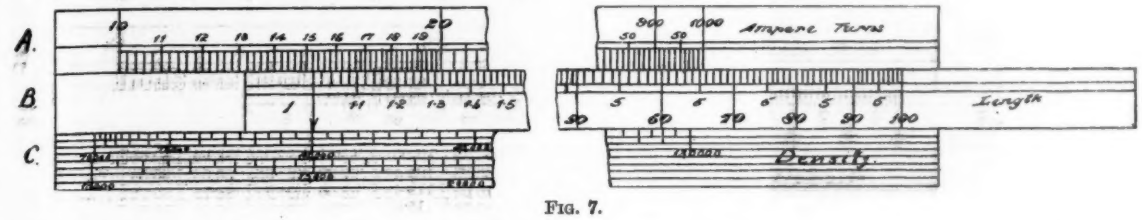


Fig. 7.

basis the proportions of a magnet coil to allow a given rise of temperature with a given number of ampère turns, neglecting the insulation on the wires, may be found by the formula,

$$L = \sqrt{\frac{\cdot 00004050 \times a^2 \times \left(1 + \frac{T \times \cdot 388}{100}\right)}{T \times M}}$$

for a series coil, or

$$L = \sqrt{\frac{\cdot 00004050 \times a^2}{T \times M \times \left(1 + \frac{T \times \cdot 388}{100}\right)}}$$

for a shunt coil, as in a series coil the watts increase with the temperature, while in a shunt they decrease.

As in a shunt coil there is usually a fair difference of potential between adjacent layers, it is desirable to place between them a layer of insulating material as shown in fig. 8. For purposes of calculation this layer has the same

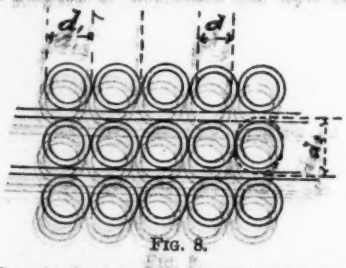


Fig. 8.

effect as though the wire were elliptical in section over the covering, as shown in dots in the figure. Taking into account the insulation on the wire, the proportions of a shunt coil are given by the formula

$$L = \sqrt{\frac{\cdot 00004050 \times a^2 \times d_1 \times d_2}{T \times M \times d^2 \times \left(1 + \frac{T \times \cdot 388}{100}\right)}} \quad (9)$$

In series coils the voltage between adjacent layers being low the insertion of layers of insulating material is not so necessary.

The dimensions of a series coil are

$$L = \sqrt{\frac{00004050 \times a^2 \times \frac{d_1}{d} \times \left(1 + \frac{T \times \cdot 388}{100}\right)}{T \times M}} \quad (10)$$

$\frac{d_1}{d}$ being in the first case unknown, may be assumed at 1·1, and a second calculation made if necessary.

* *Journal* Inst. E.E., No. 85, p. 148.

For a compound coil in which the shunt and series windings are laid side by side, the relative lengths of the shunt and series portion may be calculated by the foregoing formulæ. The total length of coil will then be L shunt + L series. If the series is to be wound over the shunt, the dimensions of the coil may be found as though they were to lie side by side, and the depth of the shunt will then equal

$$D \text{ shunt} = \frac{M \times L \text{ shunt}}{L \text{ total}}.$$

The watts' loss in a shunt coil may be found by the formula

$$W = \frac{\cdot 0000008613 \times a^2 \times g \times d_1 \times d_2}{L \times M \times d^2 \times \left(1 + \frac{T \times \cdot 388}{100}\right)}. \quad (11)$$

For a series coil it is

$$W = \frac{\cdot 0000008613 \times a^2 \times d_1 \times g \times \left(1 + \frac{T \times \cdot 388}{100}\right)}{L \times M \times d} \quad (12)$$

The weight of wire on a coil is

$$\text{lbs.} = \frac{\cdot 2524 \times g \times M \times L \times d^2}{d_1 \times d_2}. \quad (13)$$

As we cannot predict exactly the bedding of the wires, and as it is customary to bring the turns and layers to even numbers, the general formulæ Nos. 9 to 13 are only approximately accurate, but are sufficiently correct for purposes of preliminary design.

In the foregoing all linear dimensions are in inches, all areas in square inches, weights in lbs., and temperatures in degrees Centigrade. Constants are for a temperature of 15° C.

THE COUNTER ELECTROMOTIVE FORCE IN THE ELECTRIC ARC.*

By W. H. FREEDMAN, E.E.

(*Continued from page* 211.)

Examining these results, we can obtain a series, the first material having the highest counter electromotive force and the last the lowest of carbon, brass, copper, steel, iron, zinc, lead.

Table III.—Current Two Amperes.

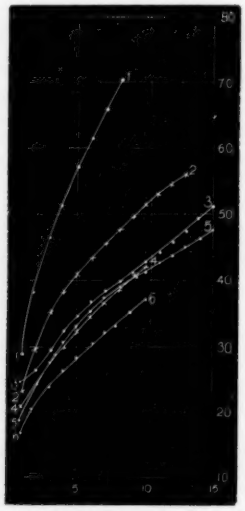
Material.	x	y	z	Formula of resistance.
Carbon ...	19·11	+ 10·05	− 0·472	$5·03d - 0·236d^2$
Brass ...	21·39	+ 3·23	− 0·113	$1·62d - 0·057d^2$
Copper ...	18·88	+ 5·69	− 0·251	$2·85d - 0·126d^2$
Steel	17·99	+ 3·49	− 0·106	$1·75d - 0·053d^2$
Iron	14·3	+ 5·00	− 0·231	$2·5\ d - 0·116d^2$
Zinc	13·76	+ 3·61	− 0·135	$1·81d - 0·068d^2$
Lead* ...	...	...	...	...

* Two ampères caused lead electrodes to melt and drop off, so no curve could be traced.

This series agrees fairly well with the contact series of metals given by Volta: graphite (carbon); platinum; gold; silver; copper; iron; tin; lead; zinc.

* *Electric Power.*

The order of the counter electromotive force series seems to be unique, for it does not agree with the orders of the same metals arranged according to melting points, specific heats, latent heats or specific gravities.



1 = carbon. 2 = copper. 3 = brass. 4 = steel. 5 = iron. 6 = zinc.
Ordinates are volts. Abscissæ are hundredths of an inch.

Fig. 4.—Current Two Amperes.

Arriving at nothing definite as yet, the experiments were repeated, keeping the current in this case at 2 ampères.

The curves obtained are shown in fig. 4, and the results tabulated in Table III.

Taking only the value of x and comparing the values for 1 or 2 ampères, we see that they do not agree at all, as shown in Table IV.

Table IV.

Material.	1 ampère.	2 ampères.
Carbon...	34·94	19 11
Brass	20 12	21·39
Copper	17 46	18·88
Steel	17·17	17 99
Iron	17·13	14·30
Zinc	15·59	13·76
Lead	12 89	...

Picking out carbon so as to eliminate the differences due to different materials, the measurements for the following additional currents were made: $\frac{1}{2}$ ampère, $\frac{3}{4}$ ampère, 5 ampères, 6·8 ampères and 10 ampères.

For the larger currents the method of procedure was slightly changed as follows:

The arc was drawn to a given distance between the electrodes and the time noted. Voltmeter readings were taken each successive minute, the current being kept constant until the arc broke.

Table V.—Material Carbon.

Current.	x.
$\frac{1}{2}$	41 64
$\frac{3}{4}$	40 21
1	34·94
2	19·11
5	48·26
6·8	44·78
10	42·12

The micrometer was then quickly turned back till electrodes were in contact and the reading of the collar noted.

From this, the amount the electrodes had burnt away was known, and therefore distance between electrodes at any given voltmeter reading could be calculated on the assumption that the electrodes burnt away uniformly.

The results from these sets of experiments are given in Table V.]

These results prove without a doubt that the "constants" of our formula have a different value for each current and that though the values deduced closely, fit the formula

$$v = x + y\,d = z\,d^2,$$

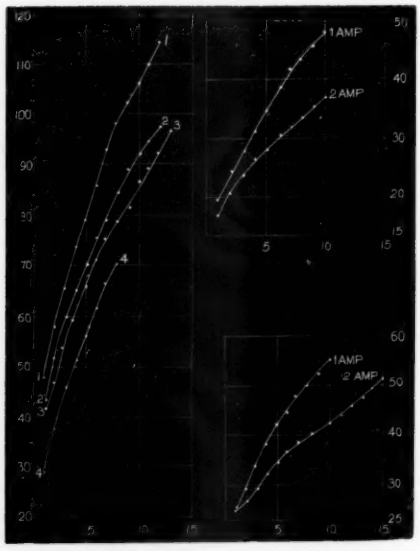
as shown in Table VI., yet they can have no real physical meaning like x being the counter electromotive force, &c., and our assumption regarding the counter electromotive force is therefore wrong.

Table VI.—Difference of Potential between Electrodes for Different Distances and Currents. Material Carbon.

Distance.	½ ampère.		¾ ampère.		1 ampère.		2 ampères.	
	Observed.	Calculated.	Observed.	Calculated.	Observed.	Calculated.	Observed.	Calculated.
1	48·00	49·56	44·00	46·61	42 00	41·72	29 00	28·69
2	58·17	59·00	51·75	52 74	47·25	48·14	38·17	37·33
3	65·40	66·92	60·00	58 50	54·25	54·20	46·57	45 03
4	73·60	74·35	65·25	64·18	59·50	59 90	51·29	51 79
5	78·50	81·28	70·25	69·50	66 00	65·24	56 62	57 61
6	85·50	87·72	75·75	74·55	71·50	70·22	61·37	62 49
7	92·50	93 66	79·25	79·34	75 50	74 84	66 28	66·43
8	98 00	99·10	84·75	83 85	79·00	79 10	70 25	69 43
9	102·25	104·04	89·00	88·09	81·50	83·00	...	...
10	106·25	108 48	92·00	92 06	86·00	86·54	..	...
11	110·00	112 42	95 00	95·77	88·75	89·72	...	...
12	115·00	115·87	97 50	99 20	92 00	92 54	...	...
13	...	...	...	...	96·50	95·00	...	...

Notwithstanding the agreement between the observed and the calculated values of the difference of potential between the electrodes, we are as yet not prepared to explain why the values of the "constants" should be different for different currents.

Fig. 6.—Curves for Zinc.



1 = ½ ampère. 2 = ¾ ampère.
3 = 1 ampère. 4 = 2 ampères.
Ordinates are volts. Abscissæ are hundredths of an inch.

Fig. 5.—Curves for Carbon. Fig. 7.—Curves for Brass.

With the hope of elucidating matters the curves in figs. 5, 6, 7, 8, 9 and 10 were constructed, the different currents for the same materials being plotted on the same sheet so that we could compare them.

We notice that without exception the curve for the larger current always lies below, and that its curvature is different from the curve for the smaller current. The remarkable fact, however, is that as the current is increased, the voltage or difference of potential between the electrodes should fall.

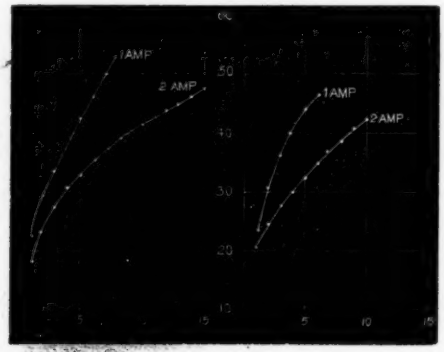
This fact can only be satisfactorily explained by first considering the following points:

1. Volatilisation of the carbon.
2. Temperatures of the electrodes.
3. Resistance of the arc.

I. *Volatilisation of the carbon.*—This, if the pressure is

kept constant, must take place at a certain definite constant temperature, following thermodynamic laws. Consequently, in an electric arc where the pressure is practically constant, being simply that of the atmosphere, the temperature of volatilisation of carbon is a constant.

In the Advanced Grade of *Electrical Engineering Leaflets*, by Messrs. Houston & Kennelly, article 233, we find: "With the same material, the distance being maintained constant,



Ordinates are volts. Abscissæ are hundredths of an inch.

FIG. 8.—CURVES FOR IRON. FIG. 9.—CURVES FOR STEEL.

the temperature at the surface of the positive carbon will be uniform if the current strength is adequately maintained. Carbon having, like other substances under fixed conditions, a fixed temperature of volatilisation (estimated at 3,500° C.), the temperature at the positive carbon, and consequently the intensity of radiation are thereby determined."

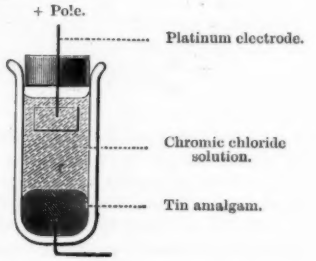
(To be continued.)

THE TIN-CHROMIC CHLORIDE CELL.*

By S. SKINNER, M.A.

THE author's construction of the cell is very much like that of a Clark cell. A test-tube with a platinum wire through the base has fluid amalgam in it, and this is covered with a solution of pure $Cr_2 Cl_6$, made by dissolving violet sublimed $Cr_2 Cl_6$ in water with the aid of a fragment of tinfoil. A platinum plate and wire form the positive pole of the cell.

Connecting such a cell at 15° C. with a galvanometer, there is a sudden deflection which very rapidly becomes less until some small steady value is reached. On warming the cell the deflection increases until it is relatively large. These observations show that the cell cannot produce a continuous current of any magnitude at low temperatures, but at high temperatures it does.



If the E.M.F. of the cell be measured on a potentiometer, or by means of a ballistic galvanometer and condenser, by either of which methods the cell is not called on to produce a current, it is found that the E.M.F. at all temperatures is approximately ½ volt, and that the E.M.F. is slightly less at the boiling point of water than at the ordinary temperature.

The explanation of the results is not difficult. The cell polarises very rapidly at low temperatures, and the opposing E.M.F. of polarisation increases so rapidly and so largely that almost at the moment of connection the effective E.M.F. becomes zero. The cell behaves like a condenser which is connected to a battery through a very high resistance. Such a condenser would discharge itself when its plates were connected, but when they were isolated again it would slowly become charged by the battery through the high resistance.

At the high temperature the polarisation is very largely reduced, and the cell will produce a continuous current.

An interesting feature of the cell is that it may be used as the mechanism of a heat-engine for the production of work, and we can trace in it the complete cycle of Carnot. Let the cell be placed in a hot chamber, and work may be derived from it until all the $Cr_2 Cl_6$ or the tin is used. Then let the cell be placed in a cold chamber, it will give up heat, and becomes restored to its original chemical condition.

Measurements of the electromotive force of two cells are given in the following tables. The first cell contained tin amalgam, and the second cell contained a tin rod. Both cells had not been used for producing current within the 24 hours immediately preceding the measurements.

CELL NO. 1.—TIN AMALGAM.

Temperature.	E.M.F.
15·5° C.	·44 volt.
20 5	·45
49·0	·43
75 0	41
93 0	·40
96·0	·40
97·0	·40
20·0	·44

CELL NO. 2.—TIN ROD.

Temperature.	E.M.F.
16°	·52 volt.
30°	·52
97°	·45

Connection was made and a current allowed to flow for 1 minute, and then the cell was allowed to rest for 1 minute:

97° | ·08 volt.

At end of second minute:

97° | ·11 volt.

At end of third minute:

97° | ·11 volt.

These results showed that the cell had polarised, and was only slowly recovering its electromotive force.

When a solution of the green chromic chloride at the ordinary temperature has silver nitrate added to it, only ⅔rds of the chlorine is precipitated. This, according to the theory of ionisation, indicates that only two atoms out of three act as negative ions, the other atom apparently being part of the positive ion. On the other hand, if a solution of chromic chloride near 100° be treated with silver nitrate, the whole of the chlorine may be precipitated. This indicates that at the higher temperature all the chlorine atoms behave as negative ions.

Taking this into account, the Grotthus chain representing the action of the cell about 15°, must be as follows:

$$Pt \mid Cl\,Cr\,Cl_2 \mid Cl\,Cr\,Cl_2 \mid Cl\,Cr\,Cl_2 \mid Sn,$$

becoming, after connection,

$$Pt, Cl\,Cr \mid Cl_2\,Cl\,Cr \mid Cl_2\,Cl\,Cr \mid Cl_2\,Sn.$$

This view of the action leaves the ion Cl Cr polarising the cell. Now if a depolariser acts so as to remove this ion, the cell will go on producing a current. The excess of chromic chloride might perform this function, forming with this ion chromous chloride:

$$Cr\,Cl + Cr\,Cl_3 = 2\,Cr\,Cl_2.$$

The behaviour of the cell shows that this does not take place readily.

A similar view of the action in the cell at about 100° indicates the presence of chromium ions as the polarising agent. At this temperature there is not much polarisation; so that it appears the following chemical change takes place readily:

$$Cr + 2\,Cr\,Cl_3 = 3\,Cr\,Cl_2.$$

* Abstract of paper read before the Physical Society, February 8th, 1895.

CALCULATIONS OF THE WEIGHT OF ACCUMULATORS REQUIRED FOR A TRAMWAY.

We think it would be interesting to establish a very simple general formula enabling us to calculate rapidly the weight of accumulators required to draw a load, A, with a speed, v, along any track whatever.

The load, A, comprises the weight, A′, of the car with the motors and passengers, plus the weight, A″, of the accumulators.

$$A = A' + A''.$$

The necessary power in kilogrammetres per second, at each point of the track, is determined by the known formula:

$$P = A\,(15 \pm r)\,v \qquad (1)$$

in which

A represents the total weight to be drawn, expressed in tons;

15, the coefficient of traction admitted for level ground expressed in kilogrammes per ton;

r, the gradient in per thousand;

v, the speed in metres per second.

Of course, r is positive in an ascent and negative in a descent. In the same way when an incline is equal to 15 in 1,000, the work to be furnished by the accumulators must be *nil* for the descent, for at each thousand the co-efficient of traction per ton is diminished by 1 kilogramme per ton. Let us examine the two following cases:—

1st. The track comprises inclines greater than 15 in 1,000.

2nd. The track only contains inclines equal to or below 15 in 1,000.

1st. In this case, the mean of the inclines, *i.e.*, the algebraic sum of the values $\pm r$ in a journey up and down, is not equal to 15, for the work furnished by the accumulators may be *nil*, but cannot be negative, as this would amount to a restitution of current to the battery. Therefore, the mean is above 15.

Let us take, for instance, an incline of 22 in 1,000, the coefficient of traction will be:

For the ascent: $15 + 22 = 37$ kg. per ton
For the descent: $15 - 22 = 0$

The mean will be $\frac{37}{2} = 18{\cdot}5$ kg. per ton. We see, therefore, that in every part of the line where the incline is above 15 in 1,000, the mean is:

$$\frac{15 + r}{2}$$

Therefore, in this first case, we must first get the sum of the products of the coefficients of traction by the lengths of the incline, for both the up and down journey (of course for the case of most general occurrence), and divide it by twice the total length. The coefficient, k, thus obtained, will be the mean coefficient to be considered. We shall thus get:

$$\frac{\Sigma\,(15 \pm r)\,l}{2\,L} = k,$$

and formula I becomes

$$P = A\,k\,v.$$

The E.M.F. of the accumulators at discharge being 1·85 volt per element, if we call I the density of current in ampères per kg. of accumulators (net weight or gross weight) under the rate of discharge adopted, we shall get

$$(A' + A'')\;k\;v = A''\,1{\cdot}85\,\frac{1{,}000}{9{\cdot}81}\,I.$$

Whence we deduce

$$A' = \frac{1{\cdot}85 + 1{,}000\,I}{9{\cdot}81\,k\,v} - 1\,A'' \qquad (2)$$

The efficiency of the motors, including gearing, being usually 75 per cent., and the losses due to startings and curves being about 10 per cent., formula 2 becomes:—

$$A' = \left(\frac{1{\cdot}85 \times 1{,}000\,I \times 0{\cdot}75 \times 0{\cdot}9}{9{\cdot}81\,k\,v} - 1\right) A'',$$

whence we get:

$$A'' = \frac{A'}{\dfrac{1{\cdot}85 \times 1{,}000\,I \times 0{\cdot}75 \times 0{\cdot}9}{9{\cdot}81\,k\,v} - 1};$$

but we see that:

$\frac{1{\cdot}85 \times 1{,}000 \times 0{\cdot}75 \times 0{\cdot}9}{9{\cdot}81}$ is a constant and $= 127{\cdot}28$;

therefore it comes out finally

$$A'' = \frac{A'}{127{\cdot}28\,\dfrac{I}{k\,v} - 1}.$$

Remark. — In a descent exceeding 15 in 1,000, the brakes have to be put on to the wheels to overcome the acceleration, which would make the speed dangerous.

The force that must be applied to the brakes can easily be calculated, for it is deduced from the theorems on inclined planes.

We can, in fact, write down, calling a the angle which the inclined plane makes with the horizontal:

$$F = A\,(\sin a - f \cos a),$$

but as:

$$\sin a = \frac{a}{\sqrt{a^2 + b^2}}\;;\quad \cos a = \frac{b}{\sqrt{a^2 + b^2}}$$

it comes out

$$F = \frac{A}{\sqrt{a^2 + b^2}}\,(a - f\,b)$$

in which:

A is the weight in kilogrammes;

a the difference of level;

b the length of the slope measured on level ground, *i.e.*, the projection on a horizontal plane of the slope;

f the co-efficient of traction, which we have assumed to be 15 kg. per ton, but which becomes here ·015.

The power in watts absorbed by the brakes will be:

$$P = \frac{v\,F}{75}\,736 = 9{\cdot}81\,v\,F.$$

2nd. When there is no incline above 15 in 1,000, the final formula is simpler still.

In fact, in this case, the algebraic sum of the values $\pm r$ is *nil*, we get therefore

$$P = 15\,A\,v = A''\,1{\cdot}85\,\frac{1{,}000}{9{\cdot}81}\,I;$$

this formula becomes with additions:

$$A' = \left(\frac{1{\cdot}85 \times 1{,}000\,I \times 0{\cdot}75 \times 0{\cdot}9}{9{\cdot}81 \times 15\,v} - 1\right) A'',$$

whence we deduce

$$A'' = \frac{A'}{\dfrac{1{\cdot}85 \times 1{,}000\,I \times 0{\cdot}75 \times 0{\cdot}9}{9{\cdot}81 \times 15\,v} - 1},$$

but as

$\frac{1{\cdot}85 \times 1{,}000 \times 0{\cdot}75 \times 0{\cdot}9}{9{\cdot}81 \times 15}$ is a constant and $= 8{\cdot}485$,

it comes out at last

$$A'' = \frac{A'}{8{\cdot}485\,\dfrac{I}{v} - 1}.$$

We often get in the data of a particular case, the ampères per kg. of accumulators for three rates of discharge only. It happens, however, since the rate of discharge is a function of the speed and of the road to be traversed, that the rate which we are obliged to assume occurs between two of the given rates or outside the three rates.

It is, therefore, worth while to establish a simple formula enabling us to calculate rapidly the current per kg. of accumulator for any rate whatever.

The curve obtained by carrying out the hours of discharge, t, as abscissæ, and the intensities, I, as ordinates, has an equation of the following form:—

$$a + b\,t + \frac{c}{t} = I. \qquad (3)$$

The values of the constants, a, b, c, can be easily established for the type of accumulator chosen, for, knowing I for

the three rates of discharge, n, n', n'', we can write down :

$$a + n\ b + \frac{c}{n} = \text{X},$$

$$a + n'\ b + \frac{c}{n'} = \text{Y},$$

$$a + n''\ b + \frac{c}{n^2} = \text{Z}.$$

We then at once get the numerical values of a, b, c, which, on being inserted in formula 3, give the value of I for a known value of t.

The addition to be made for startings may be established by the following formula :—

$$\text{in kgm. : } \text{W} = \frac{\text{A}\ v^2}{2\ g},$$

$$\text{in w. h. : } \text{W} = \frac{\text{A}\ v^2}{2},$$

in which

A is the total weight in kg. ;
v the speed in m. : s.

This quantity multiplied by the total number of startings reckoned for during the time of discharge will represent the total energy required for the startings.

The addition due to curves can only be estimated approximately, and depends on the radius of the curve, on the state of the track, and the kind of rails used. The allowance made in our formulæ for startings and curves is sufficient for the requirements of ordinary practice. It can be increased when the stoppages are very numerous, and for unfavourable conditions as regards the radius of the curve and the state of the track.—G. Chenet and H. Boy de la Tour (*L'Industrie Electrique*).

HEATING TESTS OF INSULATION.

Prof. W. L. Puffer, at the May meeting of the American Institute of Electrical Engineers, gave the results of some experiments made at the Massachusetts Institute of Technology on a large number of samples of wires, the object being to find out what strength of current passing through the wire for from, say, 10 to 15 minutes, would raise the temperature up to certain definite points which could be readily recognised without guess work or measurement of resistance. The first point was indicated by the boiling of a small drop of water placed in a small opening in the insulation. The next point was, when the slightest trace of smoke appeared. The wire was used in 5-foot lengths, 75 samples being tested. It was found that with all sorts of wires, whether with light or heavy insulation, the smoking point was identical, and no difference was noticeable between black and white covered wires.

Prof. Puffer recommends, says the *Electrical World*, as a result of the experiments described, that the safety limit should be less than 150 degrees F., as rubber begins to be injured at that point. A mathematical statement of the smoking current is that its value is 1,610 times the diameter of a wire raised to the 1·28 power. Prof. Puffer does not approve of the recent 25 per cent. increase by the Underwriters' National Electric Association in the heating limits of wire, which increase he states to be purely an arbitrary one. He believes that insurance rules ought to introduce another factor with reference to safety of life in view of the demoralisation of firemen in the presence of live wires, and the suggestion is offered to thoroughly ground the secondary wire. He looks upon the grounding of the secondary as the lesser of two evils, as it lessens the insulation strain more than grounding either side, rendering it impossible not only to receive a greater shock from any part of the service than the voltage of the plant itself between the ground and wire, while the electrostatic danger element disappears entirely.

The accompanying table was prepared to give a comparison relative to the heating of conductors. Column 1 is taken from the published curves of Kennelly's experiments, and the values contained express, as nearly as could be taken from his curves, those currents whose double value would heat a wire up to 150 degrees F. from 75 degrees F.

B & S.	1	2	3	4
0000	180	175	360	630
000	149	145	298	519
00	123	120	246	438
0	103	100	206	372
1	86	85	172	319
2	72	70	144	273
3	60	60	120	237
4	52	50	104	207
5	45	45	90	174
6	39	35	78	155
7	34	30	68	134
8	29	25	58	127
10	23	20	46	87
12	17	15	33	65
14	13	10	25	48

Column 2 contains the ratings as given in insurance tables previous to January 10th, and is an approximation to Kennelly's mathematical curve. Column 3 is a table of currents producing a rise of 75 degrees, or to the danger point of rubber coverings. Column 4 is a table of smoking points of all kinds of insulations.

COMPOUNDING DYNAMOS FOR ARMATURE REACTION.

By W. B. SAYERS.

The paper on "Compounding Dynamos for Armature Reaction," which will be found in another column, is interesting from a scientific point of view, though there will probably be general agreement with the view expressed by its author that machines of the type described are scarcely likely to develop into serious rivals with the more ordinary types. Although with the type of field employed the resultant effect of the armature current is to increase the total effective flux, and so secure a rise of E.M.F. with increased load, it does not appear that the armature is thereby rendered capable of delivering a greater out-put than could be obtained from it under normal conditions. Especially does this appear to be

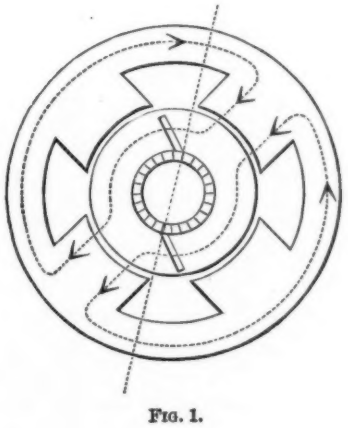


Fig. 1.

the case, when it is considered that the arrangement in question cannot apparently prevent the reduction of the commutating or reversing field to the vanishing point, or even making it a negative quantity when heavy loads are put upon the armature. In this respect the machine seems to have nothing in common with those described by Messrs. H. J. Ryan and Milton F. Thompson in a recent paper before the American Institute, referred to by the author of the paper, or the type bearing my own name. Still, the fact that with alternating wound and unwound poles an armature may be made to generate part of its working flux while the brushes

have a forward lead, as usual, is of considerable scientific interest.

It is very curious to note that, while with two wound and two unwound poles, and the brushes set in the usual forward position as shown in the diagrams illustrating the paper, the armature is capable of generating part of the effective flux; this can only be the case up to a certain point, and the breaking down which occurs after the load has reached 200 ampères is due, it seems to me, not to the causes given by Prof. Thomson in the text of the paper; but to the M.M.F. of the armature overpowering that of the wound poles.

It is quite evident that with the brushes in the forward position the armature exerts a greater M.M.F. on the wound poles than upon the unwound ones, and that this M.M.F. is, as usual, negative as regards the wound poles, although, on account of their being situated on the other side of the diameter of commutation, the effect of this M.M.F. on the unwound poles is positive.

It therefore follows that if the excitation of the wound poles were to be dispensed with, the effective flux would vanish, and the machine become inoperative, just as a series machine would do if the magnet coils were connected in the wrong way in relation to the armature. The machine, in fact, would have no more tendency to excite than one of the ordinary type with the brushes set forward. When the brushes are set backward, as suggested by Prof. Thomson towards the end of the paper, the tendency to excite, as a series machine, is due to the effect of the armature coils included in twice the angle of (negative) lead, and the effect is in no way dependent on the construction which is the subject of the paper. A self-exciting machine having no

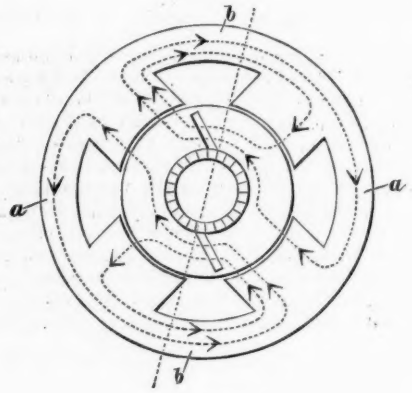


Fig. 2.

winding on the magnets, or "keepers," was described by me, it will be remembered, in my paper before the Institution of Electrical Engineers (see Vol. xxii., No. 107, *Journal* Inst.E. & E.), and, as Prof. Thomson remarks, this effect was predicted by Drs. J. and E. Hopkinson. But I fail to see any connection between this effect and the structure described in the paper. It seems to me they are wholly independent of each other.

The arrangement of field is, in fact, one which I use in combination with the armature which bears my name (see my British Patent, No. 10,298, 1893), only that the "dead poles," as Prof. Thomson calls them, are, in my case, quite small as compared with the wound ones, and are used to give a reversing flux proportional to the load carried by the armature.

The distribution of flux for heavy current in armature is, I believe, correctly represented by fig. 2, fig. 1 showing the distribution when the machine is excited only. Referring to fig. 2, the direction of flux in the limbs, *a a*, has been actually reversed by the armature current, the flux due to the magnet coils being greatly reduced in the process, and the reduced flux diverted through the "dead pole." If the load were to be pressed far enough, the remaining flux generated by the magnet coils would be extinguished, and a reversed flux (*i.e.*, of same direction as that generated in "dead poles"), generated by the armature, would take its place, the voltage, in consequence, falling rapidly. That this is what was happening when the curve, fig. 8, was taken, I think there can be little doubt.

The distribution of flux indicated in fig. 2 agrees with Prof. Thomson's curve, fig. 11, where a current of 340 ampères was being drawn from the armature.

The paper is one of very great interest, and will repay careful study. The diagrams of potentials around the commutator are specially instructive.

OUR TRADE WITH THE EAST.

Advices which are occasionally received over here from different parts of China and Japan, notably the latter, lead one to anticipate in the near future a more extensive field in those countries for electric lighting and power plant. The Americans have been somewhat active in gaining a footing in the East, and English firms have not been asleep, but there certainly seems no reason why British contractors should not carry off a very fair amount of orders, if they are only alive to their own interests, and by able representation push their manufactures before the right authorities. We have already referred to the Brazilian and African markets as presenting great opportunities to the British manufacturer, but in the East the financial risks should not be nearly so great as with Brazil and South America, nor the international competition and climatic conditions so keen and consequential as with some parts of Africa; though we suppose certain circumstances have to be considered in reference to China and Japan which would not have to be reckoned with for either Africa or Brazil. Everything considered, with facilities extended for the reasonable and proper progress of free international trade, with the natural longing of the Japanese for advance and development, and the obligatory following in their train of China, accompanied with our reputation for well made and lasting goods, Englishmen should secure at least a good proportion of well-paying business.

The development which is so desirable, while it depends upon the rising nations themselves to a very great extent, may also be brought about by English contractors and manufacturers. For instance, even in our own country, there are many places which would not have adopted electric lighting when they did, were it not that some enterprising individual or pushing company energetically wedged themselves in, and almost compelled the local governing authorities to consider the advantages possessed by the system. There are places in this country which we feel sure would not yet have dreamed of putting down municipal supply works if some outside person, or body of persons, had not signified an intention of applying for a provisional order. There is this way, and doubtless many others, in which British firms might be instrumental in bringing about developments which would redound to their own benefit in the long run, as well as to the benefit of the far away nations themselves. From a business point of view, as well as other considerations, it will pay us to do our part in developing the resources of the East. The introduction of modern improvements in machinery and plant will, in a measure, have a civilising effect, and tend to exterminate the barbarity and savagery that are at present so rampant in those parts. There are, it is true, already a number of electrical houses represented, but there is a large field and plenty of room for others without any fear of undercutting competition yet awhile.

To emphasise our remarks regarding representation in the East we may quote the following from a report of Mr. Gerard Lowther, the British Consul at Yokohama:—"It would be in the interests of British makers who . . . . . supply electric light material, and other manufactures of metals, that they had expert agents here on the spot with detailed specifications at hand when enquiry is made. . . . Electric light material is supplied from Germany and America, telegraphic apparatus from England. Japan now makes dynamos for herself with material coming from England. The telephones used are all made in this country (Japan). The supply of galvanised iron wire is mostly in the hands of German makers."

In this same connection, there was an important article in

Koln-Volksztg recently, reviewing the trade between Germany and Japan during the year 1894. In an abstracted account of the article, *Helios* says, regarding the importation of German dynamos into Japan, that whereas in the year 1892 the value of importation amounted to 73,741 yens, it was in 1894 no more than 18,120 yens. "Considering the constant increasing of German exportation on all other exportation territories, that considerable diminution in Japan must astonish us so much the more as it was not the result of an augmentation of entrance fees."

Our contemporary's opinion is that this falling off is not due to a decreased importation by Japan, for it says that "Japan is now importing more than ever, but the exportation has been withdrawn from German firms." "Besides England," continues our German contemporary, "it is principally North America, that knew how to procure its manufactures the entrance to Japan. The importation of these two countries during the same year (1894) amounted to 49,322 resp. to 145,200 yens. These countries do not owe this victory to the superiority of their articles or to their great productiveness, but only to their remarkable perspicacy (*sic*) and their great spirit of enterprise, which, we are sorry to say, we shall still try in vain to find in many parts of Germany." Another German journal, the *Ostasiatische Lloyd*, says: "The extraordinary increasing of English commerce really obliges us to adopt the thought that the merchants and manufacturers of Germany do not possess the necessary energy in order to profit of the occasions which German houses in Japan have pointed out to them. In the first place it will be necessary to establish permanent representations and to make more extensive and efficacious puffing advertisements in special and convenient newspapers. German goods must make their entrance everywhere, when they become known, because they are by far superior to any other production as to their excellent quality and solidity, and because they can make head to any foreign competition as to their prices. The industry of dynamos of Germany has been developed in an extraordinary manner during the last years; in all places where German dynamos were exhibited (we shall only mention Chicago and Amsterdam), German manufacturers have gained the first prizes, therefore it is necessary for us to try to conquer that part of the importation to Japan which our industry deserves."

The German papers quoted admit that England has the start of them in certain directions. It will now be a matter of policy with Englishmen to increase their energies, enlarge their field, engage in more active work, and carry off more of the spoil, while Germany and our other competitors are making up for lost opportunities. The hints given to German manufacturers by the German press should be taken well to heart, and turned to good account by Englishmen also. It is evident that if we are to retain and improve our hold upon foreign trade, we must lose none of that "pushing" ability for which Germany appears to hold us in esteem, but put forth more energy than ever.

ELECTRIC LIGHTING AT THE BRITISH MUSEUM.

Littérateurs, students and other visitors, who are accustomed to spending much time in the reading-room at the British Museum, must have been struck with the great pains which are taken by the officials, particularly Mr. John T. Taylor, the genial assistant secretary of the Museum, and Mr. Sachs, the electrician-in-charge, to render the lighting of the institution and the reading-room in particular as pleasing to the eye and as successful from other points of view as could be desired.

Electricity began to supersede gas at the Museum some fourteen or fifteen years ago when the Jablochkoff system was tried, and from that time up to the present year there has been an almost continuous series of progressive experiments, all of which have been undertaken for the purpose of improving the general lighting of the immense block of buildings which combine to form this celebrated collection of antiquities.

The result of these lengthy operations is that to-day there is as complete and efficient an installation as could be found in any institution throughout the kingdom. Its importance may be imagined when we mention that there are in use 130 arc lamps of various candle-powers and 3,000 16-C.P. incandescents. The Siemens plant, which is still in position, has been working for about five years.

The chief object of the experiments has been to ascertain whether arc or incandescent lighting is the more suitable under the conditions peculiar to each particular chamber. In one or two departments arc lamps were fitted up originally, but after trial, were, for certain reasons, found to be unsuitable, especially in the ethnographical chamber, hence incandescent lamps are now arranged along the ceiling in rows.

The reading-room, however, has demanded more attention than any other department. Originally, there were fitted up under the great dome a number of arc lamps, but this system was, of course, found to be too unsteady for such purposes as a reading-room requires, and accordingly, a few years ago, incandescent lights were fitted to each reader's desk. Latterly, an improvement has been effected in the shades attached to these lamps. The large arc lamps are still used, in addition to the desk lamps, though so much light seems hardly necessary.

The comfort of readers is almost too faithfully attended to, for even in the face of the almost perfect state of lighting affairs, we believe we are right in saying that there are even now captious critics ready to complain at the least little inconvenience. It is to the credit of Mr. Taylor and his staff that not one of these complaints passes disregarded.

Every year the entire installation is completely overhauled under Mr. Sachs's superintendence, the month of July being generally selected as the most convenient period. The principal alteration which is at present being carried out is the arrangement of incandescent lamps in small reflectors, after the style of shop window lighting fittings, for the purpose of showing up more plainly the backs of two top shelves of volumes which extend round the entire room. Formerly, these two rows were concealed in darkness through shadows being cast by the light from the arc lamps as it struck the edge of the gallery.

WORKING MEN DIRECTORS.

THE *Financial News* last Monday concluded a leading article on "Gas Investments" with the following paragraph:—

It is worthy of notice that the gas industry is leading the way in the association of capital and labour on new principles. This movement has as its author Mr. George Livesey, Chairman of the South Metropolitan and Crystal Palace Gas Companies, who some time since introduced the profit-sharing system for the benefit of the workmen and employés of the undertakings whose fortunes he directs. The amount of accumulated bonus and savings of the South Metropolitan workmen deposited with the executive up to a year ago was £38,000; it has now reached £41,000, and in the Crystal Palace Company it has reached £4,100. Beyond that, the workers had a year ago invested, in connection with the profit-sharing department, something like £17,700 in the South Metropolitan Company's stock. These investments have now reached £25,000; so that altogether, on June 30th, there was £66,000 standing to the credit of the workmen as the result of the profit-sharing arrangement. This is an interesting and, indeed, a very notable record. That the system of profit-sharing will be extended and imitated, no one who marks the spirit of the times can possibly doubt. But, meanwhile, an even more venturesome and novel departure is favoured by Mr. Livesey. He would not only give the workmen a share in the profits of the enterprise to the success of which they contribute; he would also give them a voice in the direction of the undertaking. The chairman of the South Metropolitan does not mean to rest satisfied until a workman-director sits with himself and his colleagues at the Board. At present, each director must have a qualification of some thousands of pounds in shares; but in the next Bill to be presented to Parliament, Mr. Livesey proposes to provide for a relaxation of that requirement. Then, when the workmen's investment has reached a specified figure, they are to be entitled to nominate one of their number to assist in the management of the company. Mr. Livesey believes in the advantages of the course he advocates; he believes in himself, and doubtless he will presently get other people to believe in a scheme on which at present they look with some misgiving. The chairman of the South Metropolitan Gas Company is a masterful man, and has intimated pretty plainly that if the shareholders wish to have him at the helm, they will have to make room for a workman-director in the crew. Thus an extremely interesting experiment is foreshadowed. How far, and in what department of joint-stock enterprise the workman-director is likely to find a footing, time alone can show.

How would it do for some of our larger electrical contracting and electricity supply companies to adopt some such method as is proposed by Mr. Livesey. It often happen

that directors of a manufacturing company are purely commercial men, possessing little, if any, experience as to the general management and the technical detail, whereas a trustworthy workman who has spent many years in active service within the workshops, would be a valuable addition to the directorate. Such a representative, provided he were not of too democratic a tendency, might do much to prevent friction, and would also be in a position to suggest economies in directions in which his co-directors might never dream of waste occurring. There may be arguments against such a procedure; but we certainly think the question is one of importance, and worthy of careful consideration.

CORRESPONDENCE.

Radius of a Brake Strap.

In your issue of July 26th, you were good enough to insert a letter from me, in which I upheld the common method of taking the diameter of the rim of a brake wheel as the acting brake diameter.

Immediately after posting this letter, it struck me that I had arrived at my conclusion by making a false assumption, and I confidently expected to find my letter either ignored as unworthy of notice, or my mistake pointed out, with your usual courtesy, in your next issue. I was not a little surprised to find that, in your article dealing with the subject, you had fallen into precisely the same error as I myself had done, and had combated my assertion by making another assumption almost equally misleading, and I became so absorbed in watching whither the discussion would eventually lead, that I forbore writing to acknowledge my error. As you appear, now, to have brought the discussion to a close, without, as I think, touching the vital part of the question, I should like to say a few words with a view to putting the matter on its true basis.

My false assumption, to which I have referred, is contained in my assertion that "the C.G. of the weight will place itself vertically under the point of suspension." As it stands, this is perfectly correct, except in so far as it assumes that there is a point of suspension, which, as a matter of fact, is not the case. If matters could be so arranged that the whole weight could be suspended from the point on the wheel, A; as, for instance, by making the rope so cohesive at that point, that the whole of the friction necessary to support the weight was produced at A, so that all the rope above A was tensionless, and not supporting any part of the weight, my contention would be correct, and the C.G. of the weight would hang vertically under the point A. As, however, in practice, the weight is supported partly by the tension transmitted from the spring balance at the opposite end of the rope, and partly by friction produced not at the point, A, only, but all over the surface on which the rope bears, it is evident that the main part of the pull is transmitted through the body of the rope, and not through the fibres which are in actual contact with the wheel at A. The effect, therefore, is, that of a force acting through the axis of the rope, and the C.G. of the weight will place itself vertically under the point at a horizontal distance, $R + r$, from the centre of the wheel, but, if anything, rather nearer the centre of the wheel, since *some* friction will be produced at the point, A, which will cause the fibres in contact with the wheel at that point to be in a state of greater tension than the rest, and therefore cause the weight to swing under slightly. It therefore appears that even with a theoretically flexible and non-elastic rope the weight would not hang vertically beneath the surface of the rim, as both you and I have assumed it would.

Your method of combating my argument by appealing to the tendency of the rope to straighten itself owing to its own elasticity, is, I think, totally wrong. If you had tried by experiment what was the elastic resistance offered by a rope, to bending it into a circle several feet in diameter, you would have found that it is a force so small as to be entirely negligible, so far as its effect in deflecting a heavy weight, such as would be used in practice, is concerned. Moreover, as everyone knows, a rope which has been strained into one position for even a short space of time by means of a heavy weight, naturally assumes that position, and loses all tendency to straighten itself.

I cannot see that your interesting device with the tapered rope has any bearing on the subject. To hang a rope over a pulley which is free to move under its influence, is to produce an effect analogous to that of a brake wheel, so perfectly smooth that no friction can be produced by it. Your experiment could equally well be performed by hanging your rope over such a wheel, when it would slip in the direction of the thicker end. To explain the action of the friction brake by means of an arrangement from which friction is entirely eliminated, is novel, to say the least of it. As an apparatus for proving that a weight produces a greater turning moment about a given centre, when acting at a greater distance from that centre (a fact which I should certainly not be bold enough to call in question), it is an ingenious, if somewhat unnecessarily complicated arrangement.

In conclusion, I would express my deep regret that any remarks of mine, even though made with the most entire innocence of purpose, should have raised the "thirst for blood" in your contemporaries or yourselves; and I shall, indeed, be happy if the above unqualified acknowledgment of my mistake can in any way contribute to the restoration of the mutual feelings of peace and friendship which have been so conspicuously displayed in the past.

E. G. Herbert.

Iron Losses in Transformers.

The appearance of a letter over the signature of "Student" in your issue of August 23rd, seeking enlightenment on the subject of transformer losses, has led me to attempt to explain the divergency of the results obtained from formulæ given, and experiments made by various eminent electrical authorities.

"Student" appears to have fallen into a very common error in taking it for granted that formulæ and results of experiments given in text-books always represent the true state of affairs. The truth of the matter is that accurate results are only arrived at by a system of trial and error, and we approach accuracy only by a series of approximations, successive trials approaching nearer and nearer to the truth.

Experiments on transformers form no exception to this general rule. Accordingly we find in Dr. Fleming's book formulæ based on somewhat imperfect experiments, which enable us to form an approximate estimate of the iron losses. We have, therefore, much to thank Dr. Fleming for in giving us at least approximate formulæ, and probably suggesting the lines on which future experiments should be made.

With regard to Mr. Weeke's results I can say nothing, as I do not know anything of the methods by which he arrived at them.

The results of Mr. Kapp's experiments were published at a more recent date than either Prof. Fleming's or Mr. Weeke's; moreover, the experiments were made on bundles of thin iron plates under conditions very closely approximating to those which obtain in actual transformers, and the results plotted down immediately from the readings taken.

Bearing these facts in mind, I felt no hesitation in accepting the results of Mr. Kapp's experiments as representing very closely the truth with regard to iron losses in transformers. The consequences of using Dr. Fleming's formulæ would not be serious, however. The only effect of using these formulæ would be that the designer of a transformer would produce an apparatus which would be actually more efficient than he supposed. Thus a good design of transformer would be produced by employing Dr. Fleming's formulæ. The results of Mr. Kapp's experiments—which I take as more accurately representing the true state of affairs than any other—enable us to form a closer estimate of the iron losses and transformer efficiency, and certainly mark a distinct advance in the state of our knowledge of transformer actions and design.

George Adams.

Bedford, *August 26th*, 1895.

ELECTRICAL POWER TRANSMISSION FOR TEXTILE FACTORIES.

The New England Cotton Manufacturers' Association is devoting considerable attention to electrical transmission, and several papers were presented to the recent Convention at Providence. Mr. Rice presented particulars of the power installation soon to be set going on the Chattahoochee River, in Georgia, where 14,000 H.P. is to be obtained from a fall of 35 feet, and transmitted 7½ miles to Atalanta. There are to be 13 units of 1,000 H.P. and 2 units of 500 H.P., consisting of horizontal axis turbines in pairs. The plant is expected not to exceed $46 per H.P. at the switchboards, and the operating expense is estimated at $4.20 per annum, including 6 per cent. interest on the investment. Another power installation proposed would cost $73.97 per H.P. at switchboard, and $6.09 operating expenses, while a third would cost $46.62, and $4.09 for operating.

Referring to textile mills, Messrs. Stone and Webster consider that distances of 25 miles can no longer be looked upon as impracticable. They would not attempt electrical transmission over distances to which mechanical driving is possible. We do not suppose they would include in this condemnation, however, the case of an old or rambling works, where the intricacies of shafting necessary render such a system costly, and it must not be overlooked that electrical transmission enables an economy to be effected in the centralisation of the boilers and engine-power. The Pencoyd Ironworks has been gradually changing to electrical methods in place of shafts and belts. A separate motor is used for each machine, or group of machines, with satisfactory results, and now the shops are almost entirely operated by electricity, a total of 1,000 H.P. being used in small units.

They consider that recent forms of induction motors possess advantages over direct current machines, being simple in construction and having no commutators. They start and stop well, and start especially well under heavy loads. At the San Miguel mines at Telluride, Colorado, power is transmitted 14 miles by means of a 700 H.P. Pelton wheel on a single phase alternator.

Mr. Eccles described a 4½ miles transmission at Tuftville of 1,900 H.P. by means of turbines, for driving 1,700 looms, 1,200 lights, and a street railway, also an electric locomotive at the mills.

Mr. Paine read a paper on the advantages of electrical transmission, of general interest. He pointed out how, by means of electrical driving, the power absorbed in any one section of a works may be readily ascertained in a way that is practically impossible with ordinary means of driving. In No. 4 mill of the Pelzer Company, no shaft is larger than 3 inches diameter, and no belt wider than 8 inches. In this mill the saving in first cost of shafting and belts, compared with an identical mill with ordinary driving, will be no less than $10,000. A further $3,000 is saved in the abolition of the belt tower. He also claims the elimination of the frictional electricity, so troublesome in textile mills.

The tendency of electrical driving is to concentration of manufacturing buildings, says this author, with which, however, we cannot very fully agree. True, the system of electrical transmission may lead to concentration of power generating plant, but ought, where circumstances permit, rather favour diffusion of manufacturing, as we believe has been the case at St. Etienne. Especially is electric driving likely to be economical where, as in a machine shop, there is liable to be much idle machinery. Few are indeed aware of the large amount of power consumed by even the best millwright work, or of the inconvenience of extending shafting to new buildings. This often means the moving of the old shafting and brackets so as to permit of the addition of the new shafting next the source of power, of larger diameter to transmit the now increased load. The author contradicts the prevailing impression that the first cost of an electrical transmission added to an hydraulic or steam plant is too great to pay. For a 65,000 spindle cotton mill with weaving attached, he says that 3,000 H.P. must be generated by the wheels and delivered to the generator. Even on this extravagant estimate of power, for such a mill ought to be served by an engine of 1,000 H.P. for the spinning, and perhaps 500 H.P. for the weaving, he thinks the advantages of better location would more than cover the extra operating cost, but the figures are not very clear; lighting is, we should fairly say, included in the 3,000 H.P.

Altogether Mr. Paine presented a good case for electrical driving so far as America is concerned. In England the problem is different. We have no great water powers, and must rather study the case from the point of view of the advocate of power generation at the coal field or ironworks, and transmission thence to industrial centres.

ECONOMY TEST OF JACKETED ENGINES.

Messrs. Hick, Hargreaves & Co, of Bolton, have furnished the *Engineer* with report of test made upon two pairs of their engines at the works of the Yorkshire House-to-House Electricity Company. As these engines are similar to those of the Leicester Station the figures may be of interest, but we give them rather as being results of a test of engines, the steam jackets of which are of the Watt type, namely, ante-rooms to the cylinder through which all the working steam passes on its way to the cylinder, the jackets acting also as water separators, a type of construction which has been in favour for some time on the continent, and was carried out by the famous Low Moor Iron Company in their engines over 70 years ago, and is found very satisfactory by Messrs. Hick, Hargreaves & Co., as, indeed, we should expect it would be, for there can hardly be two opinions as to the superiority of the method over the system of dead end jackets as usually made, half drained and full of air.

The engines tested are of the Corliss type, with cylinders 19 inches and 35 inches by 3 feet stroke, and designed to indicate 400 H.P. at 80 revolutions, with a pressure of 125 pounds. There are jet condensers, vertical air pumps driven off piston rod prolongation by L-lever, and provision for high pressure working, if needful.

The tests were made on the basis of gross feed water, a separate boiler being provided for driving donkey pumps and stokers, and the figures are reliable only to the extent of the accuracy in estimating the water present in the boilers at beginning and end of the run of about 12 hours, the start and finish being both taken running.

The results of the test show a mean I.H.P. of 377·7, and the gross water consumption of 15·362 pounds per H.P. hour with one set of engines, and with the other 385·8 H.P. and 14 63 pounds of water, of the gross feed 62·9 pounds per hour, was drained as water from the separator in the first set, and we may suppose, probably, in the second test also. No particulars are given as to the temperature of the condensing water or as to the jacket drainage which would have been useful. The non-condensing tests showed approximately 405½ I.H.P. and a water consumption of 20·31 pounds.

BUSINESS NOTICES, &c.

Annual Outing.—The employés of the Edison & Swan United Electric Light Company held their annual outing on Saturday last, a party of over 600 journeying to Brighton.

Business Announcement.—Messrs. Julius Sax & Co., Limited, inform us that Mr. W. Beale, their late representative at Robert's Mews branch, has no longer any connection, either directly or indirectly, with the company. For the present, all communications should be addressed to 7, Ridgmount Street, W.C.

Chloride Electrical Storage Syndicate, Limited.—We have received a copy of the third edition of the catalogue of this syndicate, which is published in very neat style and in pocket-book form. Full details are contained of the various types of chloride cells and accessories, also a quantity of tabulated information regarding dimensions, weights, resistances, of copper wire.

Dissolution of Partnership.—The partnership heretofore subsisting between W. O. Rooper and H. G. Tozer, carrying on business as electrical and general engineers at 11, Bridge Street, Northampton, as W. O. Rooper and Tozer, has been dissolved by mutual consent as and from December 31st, 1894. All debts will be received and paid by W. O. Rooper.

Cable Making and Wire Covering.—We have before us Messrs. Johnson & Phillips's new catalogue of cable making and wire covering machinery, which, as is usual with this firm's publications, is got up in very excellent style. The illustrations which show various submarine cable sheathing machines for different purposes, winding machinery, horizontal electric light cable machines, wire stranding and closing machines, small wire stranding machines, vertical stranding machines, electric wire and cable covering machinery (for taping, lapping, covering, and braiding), measuring machines, look very well indeed. We understand that this production occupies the unique position of being the only publication dealing so fully with this class of machinery, and in this respect it is expected to fill a long felt want. We would like to make one recommendation, which is, that in future editions the words "Johnson and Phillips," which are printed in ghastly pale blue large letters from corner to corner of the pages should be omitted. The blocks will then show to better advantage. The illustrations are all taken from photographs of the actual machines, and the designs are of very elegant form, the whole of the metal being disposed to the best advantage, this ideal construction having been reached by long experience with, and great care in the production of, each separate machine. It seldom falls to the lot of one firm to be both manufacturers and users of the same machines, but when it does, as in the present case, it cannot fail that the experience gained by actual touch with the working of the machines will result in the best design to fulfil the requirements of the work to be performed; and in this connection, Messrs. Johnson & Phillips have been enabled to give particulars of the *output* of the various machines, an item which is too often omitted from trade catalogues, and one which will no doubt be duly appreciated in the proper quarter. We understand that most of the machines illustrated can be seen in actual operation at the firm's works. There are included tabulated particulars of the sizes, capacity, ground space required, &c., for the different machines; these are given in English, and also in metrical measures. The first machine described in the book is a large "shore end" sheathing machine. This is probably the largest of its kind in the world. Its function is to armour the heaviest types of submarine cables, and at the same operation sheath with tapes and compound. Variations of this machine can be made to sheath with steel tapes or hemp yarns. The particular machine shown in the engraving has been in successful work for several years in the factory of a large Continental cable manufacturer, and is giving every satisfaction. As showing the capacity of the firm's establishment for rapidly turning out large volumes of work in cases of emergency, it may be mentioned that on a recent occasion they successfully manufactured no less than 25 of their large vertical multiple taping and compounding machines (shown on page 16) in seven weeks. An idea of the magnitude of this order can be gained when it is stated that the combined capacity of these 25 machines is 750 miles of covered wires per day. We learn that an enlargement of the already bulky catalogue is in course of preparation. It will comprise core taping, core vulcanising, cotton covering, India-rubber covering, silk covering, compounding, wire rope making, yarn stranding and wire winding gear. The catalogue is well worth perusal by contractors and others who are actively interested in this class of business, and we have no doubt if they apply to Messrs. Johnson & Phillips, they will be pleased to send them a copy.

Henry Watson & Sons v. Crossley Bros.—At the Newcastle County Court on 19th inst., plaintiffs claimed £15, the price of three Lanchester starters, which they alleged did not do the work they were warranted to do. On January 7th, 1892, plaintiffs agreed to purchase from the defendants five gas engines, for a lump sum of £1,240. Two representatives of the defendants urged upon Messrs. Watson the desirability of their purchasing, in addition to the gas engines, some Lanchester starters, the price of which was £5 each. It was stated that these starters would save hand labour, and would start the engines immediately. The plaintiffs, relying upon the skill and experience of the defendants, agreed to increase their order by the purchase of five Lanchester starters, at £5 a-piece. The engines and starters were sent, but the starters were found to be useless for the purpose for which they had been bought. The defendants sent their engineer to see what was the matter with them, but he was compelled to go away, leaving the starters practically no better than they were before. The plaintiffs complained, and the defendants replied that the starters were never represented as fit to start the engines with the shafting on; and they offered to take the starters back, and to supply their patent pump starters, which would start the engines with the shafting on, at £15 per starter. Judge Greenwell gave judgment for the plaintiffs for £15.

J. E. H. Gordon & Co.—"A Creditor" writes to the *Financial Times* regarding the above company which has been for some time in course of liquidation. He asks "when are the creditors likely to be finally settled with"; also "whether the debenture holders have been paid in full, and, if so, what surplus, if any, is likely to be left for those who trusted the company, believing it to be solvent?"

McDougall's Steam Saving Appliances.—Messrs. W. B. Haigh & Co., Ltd., have in hand at present the installation of McDougall's Stokers at the British Plate Glass Company, St. Helen's, and their tender has been accepted for large installation for the London and India Docks Company.

The Tudor Accumulator.—Mr. A. B. Pescatore has just acquired from Mr. Tudor the sole concession for the United Kingdom of his system of accumulators, and has established works for their manufacture at Dukinfield, near Manchester. The success of these accumulators during the past ten years has led this gentleman to believe that they will be equally appreciated in England. At present, more than 5,000 batteries of Tudor accumulators are working in different parts of the world. In commencing the manufacture in this country, Mr. Pescatore is enabled to profit by the prolonged and successful experience abroad. The Tudor accumulator, as at present manufactured, is composed of plates having an extremely large active surface, and consequently specially suitable for withstanding very high rates of charge and discharge. It is claimed that the cells can be discharged daily in 1 hour, and recharged in 2½ hours without damaging the plates. We have received a copy of Mr. Pescatore's catalogue giving full details of all the stationary types of Tudor accumulators. A supplementary price list of portable Tudor cells, and of a new and improved type of hand and automatic regulating switch, will shortly be issued. All communications should be addressed to the office, Haworth's Buildings, 5, Cross Street, Manchester.

ELECTRIC LIGHTING NOTES.

Bolton.—A recent report shows that there are now 70 consumers, with lamps equivalent to 5,800 C.P. connected to the mains, and other premises will shortly be connected. The electrical engineer stated that nearly 2,000 yards of new mains had been laid, and that if the contractor delivered the joint boxes in time, he expected to have the current upon one section this week. The extension runs along Halliwell Road as far as Wolfenden Street, and up Derby Street to the end of Willows Lane. The tender of Mr. W. Pollit for the excavating work required in the extension of the electricity mains to Saville Mill, Shifnal Street, was accepted. The engineer reported a slight hitch a few days ago shortly after 10 p.m. One of the glass boxes of the accumulators broke, letting out the liquids, with the result that the exciting current failed and the lights were out for two or three minutes. The new accumulators on order will have leaden outer boxes, thus preventing any similar occurrence in future.

Blackpool.—The Town Council are to consider a recommendation to spend another £30,000 upon its installation, making in all an outlay of nearly £90,000 within the last three years. The present plant is already considerably overloaded, and the demand for electrical energy is still very great.

Bristol.—The electric lighting mains are to be extended down several streets for private lighting, also to supply the new Free Library and St. Philip's Police Station. There has been a large increase in the number of applicants for supply during the month. The secretary of the Electrical Committee reported last week that applications for 20,000 lamps had now been received, and 18,000 are in use. The light is being introduced at the Prince's Theatre. Messrs. E. S. & A. R. Robinson are having their premises wired for 800 lamps. The enlargement of the switchboard at the central station has been carried out, and with the exception of the sub-stations, the work of extending the mains in Stokes Croft has been completed. The extensions in White Ladies Road are also finished, and the committee expect to be able to supply the light in the thoroughfares named about the end of next month.

Dover.—The Electric Light Company having reported to the Council that the electric lamps in King Street and Bench Street are placed in the worst possible conditions, the Council has instructed the Lighting Committee to look into the matter. The company complains that the positions were decided upon by the late surveyor.

Electric Lighting of Glass Works.—The entire area covered by the Conisborough Glass Works of Messrs. Kilner Bros. is to be lighted by electricity ready for the coming winter.

Exeter.—According to the *Parish Council's Gazette*, the Exeter Electric Light Company is not in a very enviable position of late, and there is a proposal in the wind that the City Council shall purchase the undertaking. There are also other alternative proposals.

Germany.—Owing to a majority of the Municipal Council of Golberg, in Silesia, considering that electric lighting was too expensive, the project for the establishment of a central station for the lighting of the public streets by electricity has been dropped. It is proposed to extend the plant at the central station at Frankfort-on-Main at an estimated cost of £50,000. The Allgemeine Electricitäts Gesellschaft, of Berlin, is reported to be in negotiation for the establishment of a large central station for the supply of electrical energy for lighting and power purposes in the industrial district of Upper Silesia. The company, it is stated, intends to purchase a colliery, from which the central station to be established close by will be supplied with coal. A central station is in course of establishment at Mengen (Wurtemburg). Water-power is being utilised, the plant comprising two 40-H.P. turbines. Five tenders were received by the municipal authorities of Dortmund for the establishment of a central station in that town, the lowest being that of the Allgemeine Electricitäts Gesellschaft, of Berlin.

Hospital Lighting.—The Brompton Hospital for Consumption and Diseases of the Chest is to be lighted throughout by electricity. The hospital chapel has, for some years past, been lighted with electricity, the electric power being supplied by the House-to-House Electric Light Supply Company, Limited, but now that it has been decided to light the hospital throughout in this manner, the committee will provide their own installation. Messrs. Laing, Wharton & Down are the contractors, and it is expected that

the installation—the work in connection with which has already been commenced—will be completed in about three months. The machinery is being fixed in the rear of the new extension buildings, and it will comprise a dynamo, a battery for accumulators, and a gas engine. There will be 1,209 incandescent lamps fitted. There are some 70 wards to be lighted, together with the nurses' dormitories, the doctors' bed-rooms, an entertainment hall, and the administrative and other offices.

India.—The General Post Office at Ceylon is now lighted outside by 10 arc lamps.

Towards the end of July, the Bengal Legislative Council discussed the Electric Lighting Bill, which was intended to facilitate and regulate the supply of electricity for lighting and other purposes in Calcutta. Various clauses were decided upon.

From an Indian exchange we learn that an electric light is used during night loading and unloading of steamers alongside the pier and wharves in Karachi Harbour.

Kingswood.—At the last Council meeting a long letter from the people who have taken over the electric lighting of Kingswood was read, advising several alterations and private lighting under the Council's contract. The chairman mentioned it was a matter which called for very careful handling. Of course, there would be objection raised to any alteration of the present contract, and they were in the dark as to the details. They could not have private house electric lighting very well from the overhead current wires, and therefore he advised that a small committee should be appointed to investigate the matter. Members might have observed that the light was very good on the previous night, the occasion of the flower show. Mr. Weight remarked that this only showed that a stronger light could be put on if the company wished. A committee was appointed.

Llandudno.—The Electric Supply Company have inquired of the Council whether it intends to carry its provisional order into effect itself, or whether it would allow it to be done by the company. A committee is considering the matter.

Malvern.—Mr. Perrins has received permission from the District Council to carry an electric cable across Cockshot Road, from near the stables at Davenham Bank to the Moorlands.

Newport.—The Town Hall installation is now completed. A test was made last week. The wiring and fitting of the building has been carried out by the Electric Installation Company of Westminster, whose contract was £517, exclusive of some portion of the fittings. Every room, office, floor, and corridor has been connected. In all there are 425 lights, including those in the police quarters, cells, &c. The turret clock was lit on Saturday by the new supply with 24 lights, there being six 16-C.P. lamps to illuminate each of the four dials.

Nottingham.—St. Andrew's Presbyterian Church and Schools are being lighted by about 90 incandescent lamps. This is the fourth place of worship lighted in Nottingham by Mr. Joseph Blackburn, who also has in hand the installation of 112 lights at the Masonic Hall, amongst other local work.

Railway Carriage Lighting.—For some time past experiments have been in progress on a few of the leading Russian railways for the electric lighting of the carriages. The result of these experiments, according to a London financial journal, is that the new system is to be adopted for the express and mail trains on all the lines in question.

Russia.—Negotiations are at present in hand between the Alegemeine Electricitäts Gesellschaft, of Berlin, and the municipal authorities of Kiew, with reference to the establishment of a central electric lighting station in the town.

Sheffield.—The new Empire Palace Theatre, in Pinstone Street, is to be lighted throughout by electricity, and the work of the wiring has been placed in the hands of the Sheffield Electric Light and Power Company, Limited.

Worcester.—Two water meters for testing the evaporative power of the coal used at the generating station are to be procured at a cost of £33.

Yarmouth.—The surveyor's monthly report to the Council says that since the last meeting of the Electric Lighting Committee, 421 lamps had been applied for, increasing the total number of customers to 99 for 5,122 lamps.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Birmingham Central Tramways.—One of the directors, Mr. T. J. Mantle, addressing the shareholders the other day, said that "he had come to the conclusion that so long as they worked this line by electricity on the accumulator system, so long would they have a millstone round their necks which would drag them to the ground." The chairman, in his remarks, had previously stated that on the electric section they had run 138,925 miles, a decrease of 198; carried 1,154,345 passengers, a decrease of 149,488; and earned £9,093, a decrease of £641. This was a very sad state of things, and the line showed, instead of a profit, a loss of £1,735 12s. 8d. Here, again, the company had suffered very severely during the winter, and they had also had during the year a very disastrous fire, which interfered for some time with the traffic. They were further, on this line, subjected to a very fierce competition by omnibuses, which no doubt robbed them of hundreds of passengers on the penny route. These three causes would go a long way to explain the loss, and the directors were not without hope that in the very near future the loss might be turned into a profit. They had now a very favourable contract for the supply of batteries, and when they had had sufficient time to prove the working of this contract, he thought they would be able to show much better results. For a long time batteries had been a patented article in the hands of very few manufacturers, but now the trade was open and improvements were being introduced, which the directors hoped would enable them to work the line more cheaply than at present.

Electric Pumping Plant in Hungary.—Two electric pumping engines are being put down at the Kubeck Colliery of the Austro-Hungarian State Railway Company at Anina, in South Hungary, one at a depth of 984 feet, and one at 1,968 feet. Each pump will be capable of raising 600 litres per minute a height of 984 feet. The generating plant for each pump will comprise a 80 H.P. engine and a dynamo of 55,000 watts capacity.

Electric Traction in Germany.—The Bavarian Government has granted a preliminary concession to a syndicate for an electric rack mountain railway from Leoni up Rottmann's Heights on Lake Starnberg. The construction of electric tramways between Ehrenbreitstein and Lahnstein, between Arenberg and Ehrenbreitstein, between Ehrenbreitstein, Coblenz, Luzel-Coblenz and Neuendorf, and between Ehrenbreitstein and Vallendar, has just been definitely decided upon. It is proposed to adopt electric traction on the tramways in Posen. The Union Electricitäts Gesellschaft, of Berlin, is interested in the scheme.

Electric Traction in France.—A projected line of electric tramways between Nice and the Cap de Croix district has just been declared to be for the public utility. The accumulator electric tramway between Paris and Saint Denis is to be extended to Pierrefitte. An electric mining tramway has recently been completed between Montmartre and La Beraudierre, near Saint Etienne. The generating station comprises a bipolar dynamo of 36,000 watts capacity, driven by a vertical engine of 50 H.P., constructed by Messrs. Weyher and Richemond, of Pantin. An old Crompton locomotive, with the mechanism removed, is utilised for the generation of the necessary steam. The current is conveyed to the electric locomotive along a third rail.

Electrical Railway Business in America.—Our trans-Atlantic namesake says there is a rumour that the Siemens & Halske Electric Company, of America, has formed a combination with the Yerkes interests in Chicago to oppose the recently formed Westinghouse-Baldwin alliance, to which we have already referred. The Yerkes interests comprise the Widener-Elkins syndicate, controlling important street car lines in New York, Philadelphia, Pittsburgh, and Chicago. A short time ago the Siemens & Halske Company purchased the plant of the Grant Locomotive Works in Cicero, Ill., and at the same time the capital of the Siemens & Halske Company was increased from $1,000,000 to $2,000,000.

Madras Electric Tramways.—It is pleasing to note that, notwithstanding the odds against which the Madras Electric Tramways Company has had to fight, the tramways seem to be popular, "despite the occasional growls that appear in the local press." An Indian contemporary says that between June 15th and July 15th, 1895, the cars ran 10,600 miles, and carried 101,500 passengers, and cannot, therefore, be said to have done badly.

North Staffordshire Tramways.—At Tuesday's meeting held in London of the North Staffordshire Tramways Company, Limited, the chairman (Mr. W. J. Carruthers-Wain) stated:—"Of course there is no doubt, having regard to the severe gradients with which we have to contend in North Staffordshire, the only system which can possibly be adopted there would be either the cable, or electricity by means of overhead wires. So far as the cable system is concerned, the traffic is not great enough for that, and the curves are tremendous. Therefore the difficulties of working a cable on a single road would be exceedingly great, and the expense would be tremendous. Consequently the directors are forced to consider electricity by means of overhead wires. We therefore suggested to the Town Council that if they desired us to give up the use of steam, and adopt electricity, they should give us an extension of our lease, in order to give us time to recoup ourselves for laying down such an installation. We pointed out it was perfectly impossible that in the seven years or thereabouts that remained to the company . . . . anyone would advance money, or undertake to work a line for a limited time like that. I am happy to say that the local authorities agree that if we do put up an installation of this character, they are prepared to extend our lease for a considerable period. . . . . When a proper scheme is matured for the working of the line by electricity, ... you will be called together."

Proposed Electric Cranes for Dover.—Owing to the necessity for a more rapid transference of baggage from the mail boats to the shore at Dover, the Dover Harbour Board are entering into negotiations with the Dover Electricity Supply Company for the supply of electric current for driving cranes on the Admiralty Pier for the transferring of baggage. The difficulty which presents itself is, that the current supplied by the Dover Company is alternating, and if the cranes are worked by electricity, a special main would have to be made. The company have the matter under consideration.

Propulsion of Horseless Vehicles on Public Roads.—We think there is no occasion to fear that the useful Bill which was introduced by Mr. Shaw Lefevre in the late Parliament will fall to the ground. It is a question demanding the attention of the whole House, irrespective of party, and judging from Mr. Chaplin's remarks in the House of Commons on 26th inst., it will be fairly treated. Mr. Macdona asked whether the President of the Local Government Board was aware that a petroleum motor, owned by the Hon. Evelyn Ellis, which won the first prize in the recent horseless carriage race between Paris and Bordeaux, had since then travelled in this country from Micheldever to Datchet, a distance of 56 miles, in 5½ hours, at a cost of one halfpennyworth of petroleum per hour, carrying four persons all the time; and whether, in view of the fact that this new and cheap motor might be made use of by the farmers and others in bringing their produce to their markets at an extremely reduced rate, he would consider the desirability of repealing the Locomotive Act of 1865, so as to admit of petroleum and electric motors being more extensively used in our country. Mr. Chaplin said his attention had been drawn to the subject, and he would carefully consider it in connection with the Bill introduced last session by his predecessor in office.

Proposed Tramway for Rhyll.—At a meeting of local ratepayers and others the other day, there was a discussion as to whether or not the proposed tramway should be worked by electricity. The meeting was of various ways of thinking, and adjourned in order that others might attend.

TELEGRAPH AND TELEPHONE NOTES.

Electric Motors for Shipping Cable.—The West India and Panama Telegraph Company's steamer *Grappler* (Captain Dickinson) left her moorings off Henley's Works for St. Thomas on the 25th inst., having taken on board 190 nautical miles of deep sea cable, 10 miles of intermediate, and three miles of shore end, manufactured by Henley's Telegraph Works Company; the total weight of cable is 470 tons. When shipping the cable, the hauling-in gear was driven, with complete success, by an electric motor placed on deck; the current was conveyed from the dynamo station in the works through leads running from there to the ship. We believe this is the first time an electric motor has been used for this purpose.

A Pacific Cable.—A *San Francisco Call* representative recently interviewed Mr. John W. Mackay, and several of his companions, who are interested in his telegraphic enterprises. One of these gentlemen, speaking for Mr. Mackay, said:—"It has been said that he was interested in building a cable line from San Francisco to Alaska, but I assure you there is nothing in it. . . . . The rumours you hear about the laying of a Pacific cable may come to reality, and a line may be laid from some point on the Pacific coast to Japan and Australia. Independent cables may be laid to each country. . . . . Telegraphic communication now with Australia is very expensive, as each message has to go a distance of 22,000 miles, almost round the earth. It will take $10,000,000 to build the cable as suggested, and it would be a good paying investment."

Chicago Telephones.—From the *Financial News* we learn that the Western Union Telephone Company (capital stock $100,000) has been incorporated at Chicago, which its promoters say, will furnish telephones at $30 per year.

Chinese Telegraphic Communication.—The Central News says the telegraphic service to China is interrupted, and there is no direct telegraphic communication with Pekin or Tientsin. The delay is caused by floods, and messages have to be conveyed by steamers and boats *via* Taku and Chefoo, whence they are sent by wire to Shanghai, and thence to London. The interruption has lasted for some days.

Telegraphic Communication in Turkey.—The telegraphic system of Turkey has just been extended by the opening of offices at Ridjé, the chief town of the district of Korondos, and at Ouloubourlou, near Sparta.

The Telephone Question.—The question of the telephone committee was raised in the House of Commons on Tuesday by Mr. M. Healy, who drew from Mr. Hanbury the reply that, without expressing any opinion on the subject at present, the Government would carry out the recommendation of the late committee by reappointing a committee next session to consider and report upon the evidence already given on the conditions of the telephone service and the terms of the license between the National Telephone Committee and the Post Office Department.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bedford.—September 4th. The Local Authority is inviting tenders for vulcanised India-rubber cables. Further particulars will be found in our advertisement pages.

Dundalk.—October 7th. The Town Commissioners invite tenders for an electric lighting installation. Further particulars may be obtained from our advertisement pages.

France.—Tenders are at present being invited for the supply of four kilometres of paper-insulated double-conductor telephone cable. Tenders to be addressed to the Direction Générale des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

France.—September 10th. Tenders are being invited for the supply of 24,000 copper cylinders and 100 tons of copper wire. Tenders to be directed to the Direction Générale des Postes et des Telegraphes Rue de Grenelle, 103, Paris.

Hammersmith.—September 4th. The Vestry wants complete schemes for public and private lighting and for the supply of motor power in that portion of the parish of Hammersmith described in the provisional order as the compulsory area. Particulars may be obtained from Mr. H. Mair, surveyor to the Vestry, between 9 and 5 (Saturdays, 9 and 1) on payment of £10, which will be returned to persons sending in a *bona fide* tender.

High Wycombe.—October 14th. The Chepping Wycombe Urban Sanitary authority invite tenders for working the electric lighting provisional order obtained by them within the borough, for a term of years and upon approved conditions. Tenders to be delivered to the Town Clerk, High Wycombe, from whom further details may be obtained.

Holland.—The Dutch Military Authorities are at present inviting tenders for the establishment of a small central station for the electric lighting of the De Ruyter Fort, at Willemstad. Tenders to be addressed to the Café Het Schippershuis, Willemstad, Holland.

Killarney.—August 30th. Tenders are wanted for wiring the Killarney District Lunatic Asylum; supply will be obtained from the high tension mains of the Killarney Electric Lighting Company.

Portugal.—September 4th. Tenders are being invited for the supply of 2½ tons of bronze wire, and 19½ tons of iron and steel wire varying from 1 to 4 mm. in diameter. Tenders to be directed to the Ministerè des Travaux Publiques (Direction des Services Telegraphiques et Portaux), Lisbon.

Queenstown.—September 16th. Tenders are invited for the public and private lighting of Queenstown by electricity according to the report and specification of Mr. Robert Hammond, M.I.E.E., Ormond House, London, for the Queenstown Town Commissioners. Tenders are also invited as follows: The contractor to provide the capital for the due erection of the works and maintenance thereof as per above plans and specifications, on being guaranteed the public lighting, and a stipulated number of private lights (to be agreed upon), the Commissioners having the right to purchase within a specified period. Further particulars and conditions to be had on application to Mr. James Ahern, town clerk, Queenstown.

Rangoon.—November 4th. The Municipal Committee is inviting tenders for electric lighting. Particulars to be obtained from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, E.C.

Roumania.—October 2nd. The municipal authorities of Braila, Roumania, are inviting tenders until October 2nd next for the concession for (*a*) lighting about 64 kilometres of public streets by both gas and electricity, and (*b*) 64 kilometres of public streets by electricity alone. They are also inviting tenders for the concession for the construction and operation of a network of electric tramways in the principal thoroughfares of the town. Tenders to the Maire, Hotel de Ville, Braila.

Spain.—Tenders are at present being invited for the supply of 20 tons of sulphate of copper, and 12,000 zinc cylinders for telegraph use. Tenders to be directed to the Direccion Generale de Correos y Telegrafos, Madrid.

Spain.—The Municipal authorities of Jerez de los Caballeros (Badajoz province) are at present inviting tenders for the supply and erection of plant for the electric lighting of the town. Tenders to the Ayuntamiento de Jerez de los Caballeros (Badajoz).

Stafford.—September 2nd. Tenders are wanted for wiring the County Infirmary for electric lighting. Particulars from the secretary.

Vienna.—November 14th. The Municipality of Vienna asks for tenders and plans for the construction and working of electric railways in and around the city. The notice may be seen at the Commercial Department of the Foreign Office.

CLOSED.

Belfast.—Tenders were recently submitted for the covering of the exhaust pipes at the central station and that of Messrs. Wormald & Co. was accepted.

NOTES.

Electrical Engineering in Italy.—Plans are being prepared for the utilisation of the water-power of the Brembo, at Bergamo, in the generation of electrical energy. It is stated that 1,500 H.P. will be available. Messrs. Schuckert and Co., of Nuremberg, are interested in the scheme.

The Yield of a Welsbach Burner.—*L'Energie Electrique* recently stated that, taking the yield of a Welsbach burner at nine candles per cubic foot of gas used, the same light may be obtained by burning a cubic foot of gas in a gas motor used to drive a dynamo; for with the motor 17·6 cubic feet of gas per horse-power per hour, and an efficiency of 85 per cent. in the dynamo, while the lamp uses $3\frac{3}{4}$ watts per candle, and lasts 800 hours, the quantity of power absorbed during the 800 hours is, for a 16-candle lamp, 48,000 watt-hours, or 64 horse-power-hours. This corresponds to 1,408 cubic feet of gas, or 1·76 cubic feet per hour for 16 candles, or 0·99 cubic foot per hour for nine candles, the same as the figure above given for the Welsbach. Forcing the lamp so that it has a shorter life gives, at the present prices of lamps, still better results. "But this," says the *Gas World*, "is surely the barest and baldest way of stating the problem. It may be that the cost of lamps may be set against that of Welsbach hoods; but there are other things to be considered besides the mere price of gas. And nine candles per cubic foot of gas in a Welsbach takes the Welsbach at worse than its worst; it is not even an average figure, while a steady light yield of 16 candles for 800 hours at $3\frac{3}{4}$ watts is not a well-known or common phenomenon. It may become so, possibly; but we are not there yet. The article goes on to say, and in this we quite agree with our contemporary, that the results obtained in electric lighting by limiting the area of distribution from each electric lighting station are much superior to those attained from central stations which attempt to supply larger areas. In fact, the French engineers seem to be coming to this conclusion with something approaching to unanimity."

Recent Researches on Lead Accumulators.—Our readers are familiar through these pages with the theory of M. G. Darrieus, which embraces the chemical reactions which take place in lead accumulators. According to this theory, an important *rôle* is played by the free persulphuric acid which is formed: in fact, the theory claims that this acid is the really active agent, and that during charging it is formed at the positive electrode, converting the lead oxide and sulphate into peroxide, any excess being decomposed into sulphuric acid and oxygen—a fact which indicates when the charging is finished. K. Elbs and O. Schönherr have recently been investigating the formation of persulphuric acid (*vide Zeits. für Elecktrotechnik u. Elektrochem*, 1895, pp. 417—421, and 468—472), and they now point out (*ibid*, pp. 473, 474) that Darrieus's theory is not in accord with the results which they have obtained. They state that with the small current densities which are usually employed in accumulator work, only very small quantities of persulphuric acid would be formed, even when the acid has the unusually high specific gravity (1·3) employed by Darrieus. They are aware that their results are not entirely in accord wth some recent experiments by Schoop; however, they argue that in accumulators the only matter for consideration is the question of a solution of free persulphuric acid in free sulphuric acid. They admit the large quantities of persulphuric acid can be met with occasionally in charged accumulators; but they are of opinion that this acid is present only as an accidental and secondary product, and that it is impossible that it should play the part assigned to it by Darrieus. We shall await with interest a rejoinder from Herr Darrieus.

Hermite Sanitation Process.—The War Office have instructed Messrs. Paterson & Cooper to proceed with the erection at Netley Hospital of the Hermite sanitation plant, the cost of which has been provided for in this year's Parliamentary estimates. The Corporation of Cape Town have also ordered a plant for producing electrolysed sea-water with a view to the Hermite process being applied to the sanitation of Cape Town.

Effect of Different Sizes of Carbons.—Prof. Blondel, of Paris, in measuring the total spherical intensity of arc lamps, found, says the *Electrical World*, that it was nearly trebled by diminishing the carbons from 21 and 13 mm. to 14 and 8 mm. diameter; the 13 and 8, presumably, referring to the negative carbon.

The Redcar Boiler Explosion.—With reference to this serious affair, there appears a tendency in the engineering Press to lay all the blame upon the external firing and the length as causes of seam rip and danger. It should not be forgotten that all shell boilers are liable to seam rips, and these trivial occurrences are common enough in Lancashire boilers. But, in the Lancashire boiler, we do not believe a seam rip ever caused disaster, for the reason that the furnace tubes are such very efficient longitu linal stays, that the boiler cannot part. Undoubtedly, the great length of the Redcar boilers was an addition to the danger, but, to our mind, given the existence of this type of boiler, the mistake was the omission of sufficient longitudinal staying. A boiler of $4\frac{1}{2}$ feet diameter is exposed to a longitudinal stress of one ton for each pound of internal pressure, or thereabouts, so that for 80 lbs. pressure a couple of bolts, 2 inches square, should be sufficient to stand the stress of a seam rip, even if this were to extend all round, until all pressure escaped. We think too much stress is laid on the dangers of under-firing. The practice may not be of the best, but in short boilers, longitudinally secured and free from longitudinal seams in the fire, it is not so very serious a danger, when feed-water is clean. It was not the cause of the Redcar explosions, for these boilers were unstayed, and might have gone off as they did even had they been new the day previous. They were foolishly long, and, doubtless, upon very shaky and irregular settings.

Solder for Aluminium.—A solder for aluminium which has attained to extensive use is that of an American, named Joseph Richards. He found that by adding a small percentage of phosphorus to the best solders hitherto used they were invariably improved, the particular point of advantage being their increased ability to bite on the aluminium. The best alloy thus prepared contains zinc, tin, aluminium, and phosphorus, the first two constituting the bulk of alloy, and being united in their chemical equivalents as a true alloy. This solder can be used before the blowpipe, or with a soldering iron. In the former case, a little silver can be added to it without making it too hard to melt, and giving it a better colour. For use with the copper bolt this solder leaves little to be desired. The surfaces to be united are first scraped clean, and then tinned with the solder itself, by rubbing it on hard with the bolt. The prepared edges are then soldered together with ease, using a hot iron and no flux of any description. While nothing terrestrial can be said to be so good that no better could be wished, yet in view of the improvements in soldering aluminium made since 1890, it may reasonably be asserted, says *Aluminium World*, that a satisfactory solution of the problem has been reached.

The Electro-Magnetic Medical Plaster Company, Limited.—Our readers will perhaps remember hearing of this concern on a previous occasion, when we had the pleasure of describing and illustrating the electro-magnetic plaster which was to draw a fortune from the public pocket. Apparently that endeavour has been unsuccessful, for from the *London Gazette* we learn that the company is in voluntary liquidation, as by reason of its liabilities it cannot continue its business, and liquidators have been appointed.

Fatal Accident on the Portrush Electric Tramway.—An English tourist, hailing from Lancashire, was doing a tour round the Antrim coast on a bicycle with a companion, and in trying on Monday to cross the electric tramway *en route* for Portrush, he was thrown with his bicycle across the elevated rail. He at once became unconscious, and though everything possible was done to restore animation, he died within a few minutes. At the inquest the jury found that death was caused by coming in contact with the electric rail, there being a full current on at the time.

Electrical Engineer Wanted.—The Hull Electric Lighting Committee of Kingston-upon-Hill are inviting applications for the appointment of resident electrical engineer to take charge of the electric lighting station, at a salary of £250 per annum. Further particulars will be given next week.

Electrolysis by Alternating Currents.—According to Mengarini, a voltameter interposed in an alternating current circuit behaves as an inductive resistance, creating a difference of phase between the current and the difference of potential. In the same way, in electrolysis by alternating currents, the electrodes are polarised, and we may see in this phenomenon an analogy to those which the arc (alternating current) presents. Nevertheless, according to the most recent researches—for example, Fröhlich's experimental work—there is no break in the arc. Steinmetz has shown that in the arc with alternating currents we really have to do with an apparent difference of phase; because tension and current do not affect simultaneously a purely sinusoidal form, and the deformations of one wave in respect to the next produces between the volt-ampères and the watts an appreciable difference. W. Peukert, in view of these data, proposed to see whether in a voltameter through which alternating currents passed it was possible to discover an analogous effect. A paper describing his investigation is given in the *Elektrot. Zeitschr.*, June 6th, 1895. The form of the two curves (difference of potential and current in the voltameter) was determined by the method of instantaneous contact, devised by Joubert. The electrodes were usually plates of platinum, 50 to 100 sq. cm. surface, or else they consisted of a plate and a wire of platinum, or, again, of pencils of carbon. The result obtained in each of these cases was curious: not the least difference of phase was found between the current and the difference of potential at the poles of the voltameter; and the observation was verified by observing the equality between the power measured by wattmeter and the product of the volts by the ampères. The same experiments repeated with an alternating current arc have led to the same results.

Variations in the Resistance of Solutions.—In their researches on the resistance of pure water, F. Kohlrausch and A. Heydweiller have shown that the electrical resistance of water is rapidly diminished by a current of invariable kind. This diminution is apparent with the purest obtainable water, but to a less degree. With impure water the variation does not exceed 50 per cent. The effect of changing the current is variable. More frequently a new diminution in the resistance followed by an increase is observed; but the phenomenon can be produced in the inverse order. The authors, in their paper [*vide Wiedemann's Annalen*, t. liv., p. 386 (1895)], describe experiments on the variations in the resistance of solutions under the influence of constant currents. They state that in dilute solution of sulphate of potash the resistance was, at the beginning, $1{\cdot}74 \times 10^6$ ohms, but that it fell in 67 seconds to $1{\cdot}08 \times 10^6$; in 20 minutes it was 46×10^6 ohms. At this point the current was reversed, and in 8·5 minutes a minimum resistance of $1{\cdot}74 \times 10^6$ ohms was attained, followed by a rise up to 110×10^6 ohms at the end of 40 minutes. By shaking the solution, it was possible to re-establish the initial value of $1{\cdot}74 \times 10^6$, a second minimum. In order to explain these variations, it is admitted that for saline solutions, according to Buff, 1858, there is a transference of the acid from the anode, and of the base from the cathode; this phenomenon implies a diminution of resistance. Around each electrode end there would be formed a layer of water free from salt—a sort of *halo* of pure water, and this would increase the resistance. This conclusion is in accord with those of O. Lehmann (*La Lumière Electrique*, July 7th, 1894, p. 3). Experiments made with liquids containing various colouring matters, such as cochineal, tropeolin and phenolphtaleïne, have given ocular demonstration of the existence of this *halo* of pure water around the ends of the electrodes. In the case of pure water, it is probable that electrolysis engenders hydrogenated and oxygenated compounds, which, relatively conductive, disappear in course of time.

Birmingham Central Tramways and Accumulators.—The working of the electric section of this line of tramways is as unsatisfactory as ever, as will be gathered from details in our "Traction Notes" column. The failure has been such that a further loss of £1,735 is reported upon this part of the system, while the steam and cable sections are making very satisfactory progress.

Magnetic Toys.—Many uses have been made of the attractive force between a magnet and piece of soft-iron allowed to come into contact with it, or kept in its vicinity. One of the latest is a neat application of the principle to a moving toy, which is vended by a company calling itself "The Electro-Magnetic Toy Company," although what is electro-magnetic about the device we fail to see. It is magnetic and nothing more, though very good at that, as even our august selves have spent half-an-hour over it. Briefly, it consists of a wrought-iron disc pivoted in a brass box; the pivots are of steel and are magnetised. By means of a rack and a pinion secured to the disc, the latter may be set in rapid rotation. As the upper end of the pivot projects through the top of the box, small tinned iron pieces may be brought into contact with the magnet when it is rotating, and therefore caused to perform all sorts of antics. To complete the illusion, paper figures may be fastened to the iron pieces, when they will be given movements depending on the form and size of their bases. The prettiest of all to our mind is a simple twisted strip of tinned iron, which is moved longitudinally and also circular, in three directions in fact; the whole forming quite a good example of a magnetic mechanism.

The Corrosion of Aluminium.—Aluminium is a metal which has the reputation of being difficult to corrode; but under certain very common circumstances the phenomenon of corrosion is easily placed in evidence. When describing a torpedo boat which he has built of aluminium for the French Government, Mr. A. F. Yarrow gave some interesting details of his observations on the corrosion of this metal (*vide Proc.* Inst. Naval Architects). It seems that where there is no contact with an electro-positive metal, and therefore no galvanic action, the wasting in sea-water may be taken at about 4 per cent. per annum—a loss which may be diminished by covering the aluminium with a protective paint, free from action on this metal. Several very extraordinary instances are given of the susceptibility of aluminium to corrosion when in contact with a more electro-positive metal. Thus a yacht built of aluminium in Paris, and called the *Vendenesse*, stood very well, excepting in a few places where copper fittings had been fixed in direct contact with the aluminium hull, and which had there produced a galvanic action. A similar action was also produced when the boat was moored to a quay near another boat, the bottom of which was coppered, both being fastened to the same post by means of chains. With such exceptions as these, direct contact seems to exercise very little deteriorating action upon aluminium and its alloys.

Electro-Capillary Phenomena.—The following is an abstract of a paper by H. Luggin in the *Zeitschrift für Physikalische Chemie*, 1895, xvi., p. 677, in which he describes at length his recent researches on electro-capillary phenomena. If mercury or an amalgam be made the cathode for the polarisation of an aqueous solution, the capillary constant increases with the E.M.F. until it reaches a maximum value, when the E.M.F. is equal to the potential difference between the metal and the liquid: beyond this point it decreases. Luggin carried out experiments in which the solution was replaced by a molten salt, namely (1) a mixture of lithium and potassium hydroxides; (2) sodium and lithium chlorides; (3) zinc chloride; and (4) potassium and sodium nitrates. The paper is illustrated by curves for the two latter cases. In the case of the zinc chloride no maximum is observed, whilst it occurs in the case of the nitrates at 0·69 volts below the natural potential of mercury. A number of observations are also recorded for aqueous solutions at equivalent concentrations. The first series of experiments was on alkalies and acids; for the former the mean value for the maximum was — 0·859 volt; for the latter it was — 0·882. In the case of halogen salts and organic acids, the values vary within considerable limits. Here, therefore, the potential is not independent of the nature of the solution. The influence of the metal is duly considered, experiments being made with mercury and with Liponitz's alloy. The author then discusses the bearing of these results on Helmholtz's theory, with which he is of opinion they are not in accord, and which he regards as an unsatisfactory explanation. We shall, therefore, await with interest further researches on this subject.

Selection of High Speed Engines for Electric Lighting.—Under this head Mr. F. W. Richart, in the *Electrical World*, draws attention to a few points that it is necessary to avoid in a high speed engine. For engines liable to run many hours at light load, he would avoid complication of multiple valves and use a single valve, but would use multiple valves if long continued steady load justified these undoubtedly more economical devices. Cylinders should be proportioned for about equal temperature ranges, and for variable loads compound engines are not preferable to simple engines. In a compound engine the cut-off should be equally variable automatically in each cylinder. Small clearance should be sought after only so far as this does not cripple the port sizes necessary for high speeds. Non-radiating covering is necessary; jackets are, he says, still doubtful, in which we do not agree with him, though in small units and high speed engines they may, as he says, be of doubtful utility. Reciprocating parts must not be so heavy as to be difficult of balance, and metal in a bed must be in line of stress, and transverse stresses avoided where possible. Check nuts on high speed engines which are apt to vibrate should be reinforced by spring cottars, bolts should not be too small, and nothing less than ½ inch allowed, and piston rods so usually screwed into crossheads and nutted, should have the added security of a set screw, but a good plan is to have a long thread in the crosshead, which should be split and cramped together at one end by a screw, or the rod should be screwed and riveted to the crosshead. Cylinder heads should have forcing off screws, which may be also ring bolts for lifting purposes. Machine screws needing a wrench are not convenient for this purpose, and cannot be used as lifting screws. Solid forged shafts appear preferable to built up shafts, and the crank pins of centre crank shaft should be as large as the shaft body, or a weak point will be introduced, which will be apt to spring. In the best engines the shaft is nearly half the diameter of the cylinder in the smaller sizes of simple engines. Fly-wheels should have split hubs, and be thereby cramped upon thin shafts, whereby truer running will be secured than by keying. Crosshead guide shoes may be as long as the stroke, and half as wide as the cylinder diameter, and of bronze or Babbitt lined. The crosshead pin, when not flattened on two sides to prevent bad wearing, may be made to turn round, and should be moved from time to time to make it wear evenly all round. Main bearings should be babbitted, and so should crank pin bearings. Every oil cup should be capable of being filled when the engine is running. Cylinder lubricators should have large sight tubes to allow drops to float clear of glass. Means of adjustment may be carried to excess, especially for bad attendants, who are too apt to tinker with them, and get an engine hopelessly out of adjustment. Piston valves should have some means of taking up wear, or in time will pass a good deal of steam. A good plan is to run them in removable bushings, but flat valves properly cared for, and nicely adjusted, are unexcelled for steam tightness in the author's opinion, and that, too, for long periods. Connecting rods of I section are recommended as good, light and stiff, and any kind of well made end is about as good as any other. Keys should be secured by a split pin against coming out, or by a milled groove to hold a set screw.

A Mayor as Motorman.—The ambition of some men is incredible. A New York exchange says that a certain English Duke, now deceased, was never so happy as when driving a locomotive at 60 miles an hour, and the masses highly appreciated his skill and daring. His prototype has now appeared in America in the person of a Mayor, who aspired to the more important calling of a motorman. Mayor Pingree, of Detroit, is the dignitary in question, who, dressed in the full uniform of a motorman, ran the first car over a new electric railway in that city. The local papers lay great stress on the fact that the Mayor manipulated the car entirely himself, and that "he juggled the controller and twisted the brake; he rang the bell, and bumped into express waggons. He ran past the corners where passengers wanted to get off, and failed to stop for passengers that wanted to get on. In fact, he did everything in his power to imitate the ways of the professional motorman." The amateur car driver received an ovation all along the line, and his re-election to the mayoralty is now spoken of as certain. Some folks will do anything for passing notoriety!

Bath Electric Lighting Matters.—Our readers are by this time well acquainted with the ways of the Bath Town Council and the stand captious councillors take regarding the Electric Lighting Company and its operations. We had ventured to hope that an era of peace had dawned for the company, and that they would receive a little more kindness from local gas critics. We have, however, been too hasty in our expectation, for the state of affairs does not appear to have materially changed, judging from proceedings at last week's Council meeting. The City of Bath Electric Lighting and Engineering Company were placing new contracts for the supply of carbons, and being desirous of having these of a quality which would ensure the lighting of the streets as efficiently as possible, they wisely decided to test the samples of five various manufacturers before confining themselves to any particular make. The company showed themselves anxious to please the Council as far as lay within their power, by inviting Mr. Gatehouse, the Council's official expert and inspector, to report upon the various qualities. On Saturday and Sunday, the 16th and 17th inst., the last batch of these carbons was being tested, and like the others, they were run on the street arcs in order that the conditions should be fair. Unfortunately, however, this last lot, although the most expensive, proved to be the worst, both in life and illuminating powers. They "mushroomed" to such an extent that five lamps were out between 11 p.m. and 3 a.m., and thus "a partial failure of the electric light" occurred. As the Town Council met on the Monday morning, there was not sufficient time for the company to put in a complete explanation; hence, being ignorant of the cause of the failure, a great fuss was made, and a resolution, which exhibits anything but a nice spirit, was passed, "expressing the hope that the company would not experiment any more at their expense and darkness." The Council have over and over again complained about the lighting when nothing of consequence had happened, and have requested the company to improve matters; yet it is worth noting that when the company use the power they have to remedy matters, they are requested to refrain from doing so. The Council are ever ready to blame, but very slow indeed to encourage. We are pleased to note the local press giving place in its columns to reasonable explanations. A few statistics regarding the carbon tests would be highly interesting.

The Heilmann Locomotive.—The *Electric Railway Gazette* (New York) considers that the western members of the American Institute of Electrical Engineers are little inclined to view this locomotive with favour. In their recent discussion regarding its merits, the most favourable statement was that it might prove to be a means of introducing electric traction on certain steam roads. "If the figures which were recently furnished by a French steam railway manager at the International Railway Congress in London are true, most railway companies will hesitate about experimenting with the Heilmann locomotive to any considerable extent, no matter what the cost may be. The weight of each of the two machines which are now being built in Paris will be 119 tons, or nearly 30 tons heavier than the most ponderous steam locomotive. There will be no great desire to test track construction and bridges with a fast-running machine of such a weight."

Resuscitation after Electrocution.—The New York daily Press has been interviewing T. A. Edison and Nikola Tesla, as to whether they consider it possible for criminals to be resuscitated after current has been applied for the purpose of electrocuting them. Mr. Edison emphatically stated that the method was absolutely sure, and to talk of resuscitation was nonsense. Mr. Tesla, however, would not commit himself, or, as the New York pressman puts it, "Tesla will not talk" for publication.

Arc Lamps in Series on Alternating Circuits.—With reference to our note on this subject in last week's issue, Mr. G. Braulik informs us that he has three differential alternating arc lamps of the Körting & Mathiesen manufacture burning on his premises at 217 and 218, Upper Thames Street, in series on a 100-volt circuit, and one on a 50-volt circuit, 10 ampères, with excellent results.

Journalistic Scrapping.—In a recent issue of the New York *Electrical Engineer* there appeared an illustrated description of an electrical head-gear arrangement for the use of pugilists. The *Referee* of 18th inst., referring to the description, gave credit to the *Electrical Engineer*, omitting to state that it was meant for the New York journal of that name. The London *Electrical Engineer* writes as if the allusion was intended for itself, resents it, and appears to want all the world to understand that it has never done anything to the *Referee* writer that he should credit it with taking the least notice of his sporting notions.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

J. H. Pickup and Company, Limited (34,051).—This company's annual return was filed on June 26th. The whole capital of £15,000 in £5 shares has been taken up, and 800 have been considered as paid; £3 per share has been called and paid on 2,200.

River Plate Electricity Company, Limited (28,213).—This company's annual return was filed on July 17th. The capital is £500,000 in 49,900 ordinary, and 1,000 founder's shares, the former of £10 and the latter of £1; 13,557 ordinary and 892 founders' have been taken up, and 2,400 were considered as paid. The full amount has been called on the rest, and £110,892 has been paid, leaving £1,570 unpaid.

Phonopore Company, Limited (25,480).—This company's annual return was filed on July 2nd. The capital is £150,000 in £1 shares (50,000 preference), 90,000 ordinary and 28,343 preference have been taken up, and 69,025 ordinary and 10,380 preference have been issued as fully paid. The full amount has been called on the rest, and £38,791 15s. has been paid, leaving £146 5s. to come in.

Hastings and St. Leonards-on-Sea Electric Light Company, Limited (16,505).—This company's annual return was filed on June 7th, 2,722 shares have been taken up out of a capital of £50,000 in £10 shares, and the full amount has been called and paid. £5 has been also paid in respect of five forfeited shares.

Hubert Grenfell, Limited (43,086).—This company's statutory return was filed on June 10th. The capital is £12,500 in £1 shares (2,500 preference); 8,250 ordinary and 895 preference have been taken up, and the former are considered as fully paid. The full amount has been called and paid on all the preference.

Jones Brothers & Co., Birmingham, Limited (41,562).—This company's statutory return was filed on June 1st. The capital is £2,000 in £1 shares (1,000 preference); 807 ordinary and 300 preference have been taken up, and all but 7 ordinary have been considered as paid. Nothing has been paid on the rest.

Saxby & Farmer, Limited (38,786). This company's annual return has just been filed. 2,021 shares have been taken up out of a capital of £25,000 in £10 shares, and 1,800 were considered as fully paid. The full sum has been called and paid on the rest.

J. E. Hopkinson & Co., Limited (37,883).—This company's annual return was filed on June 7th. 16,407 shares have been taken up out of a capital of £20,000, in £1 shares, and 10,000 have been considered as paid. The full amount has been called on the rest, and this, with the exception of £276, has been received.

Sheffield Electric Light and Power Company, Limited (36,351).—This company's annual return was filed on April 25th. The capital is £98,000 in £7 shares. 8,625 shares have been taken up, and 4,000 have been considered as having £5 per share paid. A call of £2 has been made on 8,625, and £16,709 has been paid, leaving £541 to be received.

Johannesburg Lighting Company, Limited (in liquidation). (35,248).—This company's annual return was filed on June 27th. The capital is £127,132 in £1 shares (50,000 preference). The whole has been taken up, and with the exception of 7 ordinary shares, has been considered as paid. £7 has been paid on these shares.

United Electric Tramways, Limited (37,395).—This company's annual return was filed on May 21st, when 3,007 shares were taken up out of a capital of £30,000 in £5 shares. Of these 3,000 have been considered as paid, and £35 has been paid on the rest.

Vaughan & Brown, Limited (43,247).—This company's statutory return was filed on July 8th. The capital amounts to £40,000 in £5 shares (4,000 ordinary and 4,000 preference). 2,620 ordinary and 2,600 preference have been taken up, and 2,000 of each description have been considered as paid. The full amount has been called, and £6,100 paid.

Llandudno Electric Supply Company, Limited (41,382).—This company's annual return for 1894 has just been filed. Fourteen shares have been taken up out of a capital of £15,000 in £10 shares, and the full amount has been called and paid.

Telegraph Manufacturing Company, Limited (23,482).—This company's annual return was filed on June 21st. 3,310 shares have been taken up out of a capital of £50,000 in £10 shares, and 646 have been considered as fully paid. The full amount has been called and paid on the rest.

West Coast of America Telegraph Company, Limited (11,933).—This company's annual return was filed on July 2nd. The capital of £300,000 in £10 shares has all been taken up and paid for in full.

Michael Corbitt & Sons, Limited (42,379).—This company's statutory return was filed on July 13th. Seven shares have been taken up out of a capital of £50,000 in £10 shares, and nothing has been called or paid.

Acme and Immisch Electric Works, Limited (40,125).—This company's annual return was filed on July 24th. The capital is £25,000, in £1 shares (5,000 preference). 19,042 ordinary and 4,140 preference have been taken up, and 15s. per share has been called on the preference shares. £2,917 10s. has been paid, leaving £187 10s. unpaid. The ordinary shares are all considered as paid.

Oswestry Electric Lighting and Power Company, Limited (38,303).—This company's annual return was filed on May 22nd. 2,021 shares have been taken up out of a capital of £10,000, in £1 shares, and 1s. 6d. per share has been called, and, with the exception of £8 15s., paid.

CITY NOTES.

Derby Corporation Accounts.

We have before us a copy of the Derby Corporation electric light accounts to March 31st, 1895. The electric lighting works were taken over from the contractors on July 31st, 1894, and all charges for maintenance and interest up to that date are included in the capital account, the total outlay under this heading being £48,246 6s. 7d. The revenue account, which covers the period from August 1st, 1894, to March 31st this year, shows the cost of coal, salaries, office expenses, repairs and maintenance of plant, also Messrs. Siemens Bros. & Co.'s charges for working the station since it was handed over, as £2,534 3s. 1d., to which has to be added bank interest and interest on loan, August, 1894, to March, 1895, £700, and repayment of loan for one year, £1,023, making the total on this side of the revenue account, £4,257. The credit side of the account includes charges for electric current supplied to March 31st, £5,718 9s. 1d. (public lamps £2,744 16s. 8d.; other accounts, £2,973 12s. 5d.). Deducting £1,555 13s. 5d., the amount paid to Messrs. Siemens for working station to July 31st, 1894, and adding for sundry accounts and rents received the sum of £50 18s. 5d., there remains a balance of £43 9s. to be carried forward.

South Staffordshire Tramways Company, Limited.

At the fifth ordinary meeting of this company, held on Monday at the Cannon Street Hotel, Mr. W. S. Schuster moved the adoption of the report, which, he said, covered a period of two years' working, although the present directors had only had the management for six weeks. He stated that the contract made with the Electric Construction Company before the present board came into power they had repudiated entirely, on the ground that it was so one-sided, that no Court would uphold it. Certain persons wanted the company wiped out, but the present directors had resisted these attempts, and up to the present date the Court had supported the directors' action.

The report was adopted.

Stock Exchange Notices.—Application has been made to the Stock Exchange Committee to allow Edison & Swan United Electric Light Company, Limited—17,139 "A" shares, Nos. 01 to 05,800 and 05,802 to 017,140 to be quoted in the Official List.

International Cable Company, Limited.—The official liquidator announces a final dividend, by order of Mr. Justice Stirling, at the rate of 5s. 3¾d. per share.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending August 25th, 1895, amounted to £875: week ending August 26th, 1894, £878; decrease, £3; total receipts for half-year, 1895, £6,883; corresponding period, 1894, £6,941; decrease, £58.

The Liverpool Overhead Railway Company. The receipts of this railway for the week ending August 25th, 1895, amounted to £1,318; corresponding week last year, £1,094; increase, £224.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 23rd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,945.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation August 21st.	Closing Quotation, August 28th.	Business done during week ended August 28th, 1895. Highest.	Lowest.
173,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	102 —105	102 —105	...	...
1,912,880*l*	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	47 — 49	47 — 49	...	...
2,993,560*l*	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	88 — 89	89 — 90	89¼	...
2,993,560*l*	Do. do. Defd.	Stock	...	...	...	8⅛— 9	8½— 9	...	...
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	6½% §	...	13⅜— 14¼	13⅜— 14¼	...	...
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	111 —115	111 —115	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	10%‖ §	... §	2½%	3 — 3½xd	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —165	160 —165	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	2 % §	1½%	1/16— 1/8	1/16— 1/8	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14 xd	13 — 14	13½	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21 xd	20 — 21	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	9⅜— 10¼	9⅜— 10¼	...	...
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	...	4½%	103 —106	103 —106 %	...	...
60,710	Direct United States Cable, Ltd.	20	3½% §	2⅝% §	2 %	9 — 9½xd	9 — 9½	9 1/16	9
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	6½%	17 — 17¼	17 — 17¼	17¼	17⅛
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 % §	6 %	17⅜— 18¼	17⅜— 18¼	18⅛	...
102,100*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	105 —108	105 —108	...	...
1,297,837*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	127 —130	127 —130	128½	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17½— 17⅝	17⅝— 17⅞	17⅞	17½
54,100*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	102 —106	102 —106 xd	...	...
194,300*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	103 —106	103 —106	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	126 —129 xd	125 —128	...	...
80,600*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	102 —106	102 —106	...	...
107,600*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	103 —106	103 —106	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	105 —108	105 —108	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	112 —115	113 —116	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅞% §	4⅝% §	4⅛%	10¼— 10⅜	10⅛— 10⅜	10⅛	10⅛
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 %	17⅛— 17⅝	16⅞— 17⅛	16 15/16	...
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	8⅜%	21¾— 22¼	21¾— 22¼	...	...
180,000*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	105 —108	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	50 — 53	50 — 53	...	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	2 %	2½%	1½%	5 — 7	5 — 7	...	...
100,000*l*	Do. do. 6 % Debs.	100	6 %	6 %	6 %	107 —111	107 —111	...	...
28,000	Monte Video Teleph. Co., 6% Pref., 1 to 28,000 ...	5	*nil*	4 %	...	1½— 2½	1½— 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 % §	5 %	5⅝— 5¾xd	6 — 6¼	6 3/16	5 15/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18 xd	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 16 xd	15 — 16	15¾	15⅝
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6¼xd	6 — 6¼	...	...
1,100,000*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	106 —108	106 —108	107	106½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4¼%	9/16— 11/16	9/16— 11/16	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	107 —110	107 —110	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	*nil*	3½— 4½	3½— 4½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	126 —131	127 —132	...	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2½— 3	2½— 3	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	92 — 97	92 — 97	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	...	*nil*	5½— 6½	5½— 6½	...	...
238,300*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	105 —108	104 —107	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½— 2½	1½— 2½	...	...
150,000*l*	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	99 —104	99 —104	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3 %	10¼— 10⅜	10¼— 10⅜	10⅜	10 5/16
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½— 7	6½— 7	6½	...
33,129	Do. do. do. Def. Ord.	7½	...	...	1 %	4¼— 4⅜	4¼— 4⅜	...	...
165,200*l*	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	101 —105	101 —105	...	...
206,400*l*	Do. do. do. do "B," do.	100	6 %	6 %	6 %	101 —105	101 —105	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	⅛%	¾— 1	¾— 1	⅞	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10 — 10½	10 — 10½	10 7/16	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	8½— 9½	8½— 9½	8⅞	...
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	110 —113	110 —113	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$100	7 %	7 %	7 %	113 —118	113 —118	...	...
164,300*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	102 —104	102 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5½— 5⅝	5½— 5⅝	5 5/16	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	...	...	...	6¾— 7¼	6¾— 7¼	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	...	116 —118	116—118	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	14½— 15	14½— 15½	15½	15
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15½— 16½	15½— 16½	16	15¾
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	131 —134	131 —134	...	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	8½— 9½	8½— 9½	...	...
10,000	Do. do. do. 6% Pref., £4 pd., 40,001—50,000	10	...	...	...	6 — 6½	6⅜— 7¼	6⅞	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5½%	7⅛— 8¼	7⅛— 8¼	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2½%	3 %	10¾— 11¼	11⅛— 12½	11¾	11 7/16
150,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	116 —119	117 —119	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	8½— 9	8½— 9	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	4½%	6½%	8 — 8½	8½— 8¾	8½	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 9½	9 — 10	...	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	7⅞— 8¼	8¼— 9	...	...
8,000	Do. do. do. Ord., 60,001 to 68,000 ...	5	...	...	...	7⅞— 8¼	8¼— 8¾	...	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‡ Dividends paid in deferred share warrants, profits being used as capital

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, Aug. 21st.	Closing Quotation, Aug 28th.	Business done during week ended Aug. 28th, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	6 % §	6 % §	...	2 — 2¼	2 — 2¼	2¼	2 5/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	6 % §	...	2 — 2¼	2 — 2¼	...	...
125,000£	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	112 —115	113 —116	...	...
630,000£	City and South London Railway	Stock	⅝%	⅝%	1¼%	41 — 43 xd	38 — 40	39	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	1 — 2	1 — 2	...	...
89,261	Edison & Swan United Elcc. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	...	...	5 %	2 — 2¼xd	2 — 2¼xd	...	...
100,000	Do. do. do. 4½% Deb. Stock Red....	Stock	...	...	4½%	104 —107	104 —107	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	...	¾ — 1	⅝ — ¾	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2 — 2½	2 — 2½	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	¾ — 1	⅝ — 1	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	⅞ — 1⅛	⅞ — 1⅛	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	¼ — ⅜	¼ — ⅜	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½ — 7½	6½ — 7½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	5 %	11 — 11½	10½ — 11½	...	...
3,000	Do. do. do. 7% Pref.	10	...	...	...	15 — 15½	15 — 15½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	...	106 —109	106 —109	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	19 — 21	19 — 21	...	...
200,000£	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	102 —104	102 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	10 1/16 —10 1/16 xd	10⅞ — 11	...	...
10,000	† Do. do. Pref., £10 paid	10	...	5 %	5 %	15 — 15½xd	15 — 15½	...	..
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	43 — 45	43 — 45	44¾	43¾
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	4⅜ — 4⅝	4⅜ — 4⅝	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1893—0%; 1891—7½%; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¾—6¼.
Electric Construction Corporation, 6 % Debentures, 95—100.
House-to-House Company (£5 paid), 3⅞—4¼.
Do. do. 7 % Preference, of £5, 8—8½.
Do. do. 4½% Debentures of £100, 108—110.
Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 8—8½; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.
Liverpool Electric Supply, £5 (fully paid), 8 1/16—8 3/16.
London Electric Supply Corporation, £5 Ordinary, ⅞—⅞.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 5¾—6¼.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

THE FOLSOM WATER-POWER UTILISATION.

A rather important installation of water-power for generating electricity of about 4,000 horse-power, to be transmitted to Sacramento, a distance of 24½ miles, has arrived at completion in California, and is described in the *Engineer*. The American river has been dammed by a masonry structure, 89 feet high, and 650 feet in length, which has formed a 13-million cubic yards reserve of water. From this are led two canals; one is already complete, and extends to Folsom, about two miles away, giving 1,200 horse-power for the service of the State of California on its route, by the loss of 7·3 feet of head, and leaving 55 feet fall available at the Folsom power-house, where are placed four pairs of double discharge horizontal shaft turbines, of 1,260 H.P. each, at 300 revolutions per minute. They have inlet pipes of 8 feet diameter. The three-phase system is employed, and consists of four alternators of 800 volts at 60 ~ direct connected to the turbine shafts, and of a power of about 1,000 H.P. each, and weighing 90 tons.

The exciters are of small multipolar type, direct coupled to small turbines, at 600 revolutions and 500 volts. There are two of these, each large enough to excite all four dynamos, and there are step-up transformers to raise the voltage to 11,000. The pole line will be in duplicate, as a safeguard against stoppage, and it will run parallel with the railroad, and contain 2,600 poles, each 40 feet high by 16 inches butt diameter, with two cross arms, one for each circuit, carrying No. 1 copper wire on double petticoated insulators, tested to 25,000 volts, with suitable cut-outs, &c.

At Sacramento are step-down transformers, to deliver current at 125, 250, 500, 1,200 and 2,000 volts as required. There are also three 300-H.P. three-phase synchronous motors, at 400 revolutions, driving a line shaft to operate four railway generators for the Sacramento tramway service.

Fœsch and Picard governors are provided for speed regulation of the large turbines in conjunction with heavy fly-wheels, and the transformers, which have a capacity of 250 watts, are provided with numerous air-ducts, which keep the temperature below 60° C. The 200 kw. transformers at Niagara have a maximum rise of 35° C. It is expected that, in event of this transmission scheme proving economically successful, there will be a great impetus given to the utilisation of the many water-powers of the United States.

A CHIP FROM A TRUE WORKSHOP.

Mr. Leonard Paget, Ph.D., writing in the New York *Electrical World*, submits an instance of the manner in which great minds operate. In all our electrical science, none stands pre-eminent to Gaston Planté, whose intuition was equalled only by his own power of practical deduction. The accompanying letter is self-illustrative, and stands as true to-day as when written in sunny France nine years ago. It is a powerful example of true work founded on a sound experimental basis, for the results given might have been stated yesterday, and yet have been as new as when given.

(*A Letter from M. Gaston Planté to Dr. Leonard Paget.*)

Bellevue-sous Meudon (Seine et Oise),
June 16th, 1886.

Dear Sir,—I received your letter of June 2nd, and read it with great interest. I regret that attendance to the necessary details of settling in the country for the benefit of my health has not permitted me to answer it until to-day.

Before dealing with the two questions submitted to me therein, I will recall to your attention the inquiry made in your letter of December 30th, 1884. You then wrote to me:—

"Given in an accumulator a certain weight of plate, what is the highest theoretically possible number of coulombs to be obtained,

supposing the whole of the substance of the plate to be acted on? In other words, one gramme of peroxide of lead has a certain value in coulombs or ampère-hours. What is this value?"

You, at the same time, state that you have found this value to be, theoretically, 4·48 grammes.

I answered you that I found just one-half, or 2·24 grammes.

But I calculated as if the peroxide of lead had been reduced to the metallic state from PbO_2 to Pb, while it is better to calculate as if the peroxide, PbO_2 were simply reduced to the state of protoxide, PbO,* and in that case, in fact, we have 4·48 grammes, exactly as you have found.

You now write:

"What I want to know is what you consider the weight of peroxide actually used in your original and recent accumulators per ampère-hour of capacity?"

I think you must have meant also "and per kilogramme of lead;" for if we do not count the weight of lead cast into the accumulator, but merely the weight of peroxide of lead relative to the number of coulombs or ampère-hours it can furnish, we arrive precisely at the theoretical figure of 4·48 gr. So, if I understand your question, you wish to know how much peroxide of lead I can produce or reduce with an accumulator of a given weight (1 kilogramme, for instance), and, consequently, how many coulombs or ampère-hours I can obtain.

Here is one of my latest results, which does not, however, state the utmost possible capacity of my accumulators; since, as I have often repeated, by again changing the direction of the current, we may hope to increase in that manner the capacity, which has no other limit than that determined by the internal thickness of the lead plates, or, say, one-half, so as to leave a sufficient internal conducting body.

I have obtained by the discharge of an accumulator, the two plates of which weighed 1 kilogramme, a deposit of about 20 grammes of copper.

Admitting in round numbers that the deposition of 1 gramme of copper represents an expenditure of 3,000 coulombs, this would make about 60,000 coulombs per kilogramme of accumulator lead (or more than 16 ampère hours, admitting that the accumulator is discharged exactly in one hour, and that the current is constant during the entire discharge, which is not the case. Moreover, it is not exact to thus give the valuation in ampère-hours, and I prefer to simply indicate the number of coulombs obtained). This being stated, if it is desired to know the weight of peroxide of lead, which ought to be formed during the charge and reduced (let us admit only in the state of protoxide during the discharge), we have, by taking the equivalents of copper and lead, 32 and (104 in round numbers): For 32 of deposited copper 8 of oxygen set free, which is capable of oxidising 104 of lead, from which, for 1 gramme of deposited copper we can oxidise 5·25 of lead; for 20 grammes, 65 grammes of lead.

Thus there are only 65 grammes of lead at work at the time of discharge, corresponding to about 75 of peroxide (in round numbers), which must be formed at the time of charging.

Now these 75 grammes of peroxide gave 60,000 coulombs; whence, for 3,600 coulombs, or 1 ampére-hour, there should be formed 4·50 grammes of peroxide of lead.†

This result appears to agree with those which you have obtained on your part.

The second question which you put to me is the following:—

You desire to know the force of the current in ampéres with which I can charge or discharge my accumulators without inconvenience (without danger of disintegrating the formed peroxide, or the reduced lead upon the plate), that is, if I have properly understood what you call "the safe ampère charge and discharge."

I give it an approximate value of from 8 to 10 ampères per square metre of total surface of my secondary couples (counting the double surfaces of each of the plates) for the charge.

For the discharge I believe we may, without inconvenience, discharge with a notably stronger expenditure, if the end pieces or flattened parts of the plates are sufficiently thick not to become heated, and consequently get brittle, under the influence of the passage of the discharge current.

I have made no experiments with the sulphate of magnesia which you spoke of according to the results obtained by Mr. Desmond FitzGerald. But his experiments, as well as your own, no less strongly interest me.

Accept, my dear sir, the renewed expression of my very marked and devoted sentiments.

(Signed) Gaston Planté.

THE BRAILA CONTRACTS FOR ELECTRIC TRAMWAYS AND LIGHTING.

Summary of Conditions.

As previously mentioned in these columns, tenders are being invited for the construction and working of a system of electric tramways, and for the concession for the supply of gas or electric light for public and private purposes in the town of Braila, Roumania. We have now received a copy of each of the specifications, and it may be interesting for the benefit of intending contractors, to give a brief summary of them. The specifications, issued by the Conseil Communal, have been approved by the Conseil Technique and by the Ministère de l'Intérieur.

Electric Tramways.

The town of Braila gives the exclusive right of establishing a tramway system worked by means of self-contained (accumulator) cars, the duration of the concession being 35 years from the date of the contract being signed. At the expiration of that period, the town will become the owner, and will at once take possession, without the payment of any indemnity to the concessionaire, of the lines, works, machinery, cars, shelters, stores, &c., or, in other words, of all the fixed installations and of the rolling stock. A detailed inventory of all the plant employed by the concessionaire is to be prepared every five years, the control of this being in the hands of the engineer-in-chief of the town.

The lines included in the concession comprise the following: (1) From the railway to St. Archangeli Place; (2) from the Galati Barrier to St. Archangeli Place; (3) from the docks along the quays and the Strada Danubiului to St. Archangeli Place; (4) from the docks to the Strada Calarasilor, *via* the Boulevard Carol I-er; and (5) from St. Archangeli Place to the Monument, *via* the Strada Calarasilor. It is only these lines which form the subject of the present concession, and the town reserves the right of granting facilities to others for the working of tramways in the town, or outside of it, if the concessionaire of the five lines enumerated refuses to lay down and work new lines asked for by the Mayor. In case the contractor obtains powers from the State to establish a tramway service to Lacul-Sarat, the town of Braila will grant, free of cost, permission for the laying and working of the line, in so far as its district is concerned.

All the plant required in the construction of the tramway will, for a period of 10 years, be exempt from octroi duties. The concession cannot be transferred to another party without the authority of the Mayor. All the lines must be set in operation within 18 months of the signature of the contract. There will be 11 stopping stations, at each of which a covered shelter for the accommodation of waiting passengers must be provided. Any disputes which may arise concerning the specification will be adjudicated upon by the ordinary tribunals. Those who propose to compete for the concession must forward with their proposals the sum of 10,000 francs (£400) in cash or in Roumanian securities.

The material required to maintain in good condition the roadway between the two tracks, and a portion on each side of them, will be paid for half by the town and half by the contractor. In consideration of this, the concessionaire will pay to the town so much per cent. of the gross receipts from both passenger and goods traffic. The works (generating station and depôt) will be erected on the border of the town on ground which will be gratuitously handed over by the Mayor. The cars are to be provided with imperials, that is, outside passenger accommodation; and speeds of 9·3 miles an hour in the town and up to 24·8 miles outside will be permitted. Trailers may be used. Various penalties for non-fulfilment of the contract will be imposed.

Tenders are to be addressed by October 2nd to the Maire (D-lui Primar al Urbei Braila, Roumania). Each offer is to contain:—(1) A statement that the tenderer understands and accepts the conditions of the specification; (2) a description of the accumulator car system proposed to be introduced; (3) a description of the tramway track; and (4) the percentage which the concessionaire will pay of the gross receipts to the town.

Gas or Electric Lighting.

In this case two proposals may be made. The first is a mixed system of gas and electricity, and the second the lighting of the town by electricity. The former comprises the lighting of the whole of the town by gas, and in 12 kilometres of streets, in addition to gas mains, a system of electrical distribution can also be introduced. The latter comprises the use of either arc or incandescent lamps, or a mixture of the two. The lighting of the quays, and of five streets mentioned, is not included in the contract, although the town may subsequently allow these to be added. The concession is for (1) the public lighting of the streets and roads, municipal and other buildings, and for the supply of gas and electric light to private consumers; (2) and the exclusive right of establishing upon or under the streets, &c., mains for both public and private illumination.

The concession, as in the case of the tramways, will be for 35 years, at the end of which the whole of the works will become the property of the town. The generating stations are to be erected on the border of the town, and for this purpose two hectares of land will be provided free of cost by the town. The period within which lighting is to be commenced is 18 months from the signing of the contract, and if thought desirable, the town may experiment upon a length of 500 metres with other systems of lighting during the concession. A deposit of 50,000 francs (£2,000) must be made on the conclusion of the agreement.

The mains may be erected overhead or underground, but the town reserves the right of insisting that one-fifth of the total length shall be placed underground. In case the town be lighted both by gas and electricity, the gas mains are to be laid also in those streets illuminated by the electric light. In the case of electric lighting, the unit will be a 16-C.P. lamp taking 50 watts; and a 8-ampère arc lamp will be considered as equivalent to eight 16-C.P. lamps, a 10-ampère as equal to 10 16-C.P. lamps, and a 12-ampère lamp as 12 16-C.P. lamps.

Those desiring to compete must send with their offers a provisional guarantee of 25,000 francs (£1,000); a description of the system proposed to be introduced for the distribution of gas and electricity

* Which is, perhaps, more in conformity with what occurs on the discharge of an accumulator.

† If the accumulator is in continual service, my opinion is, that the primary current does not have to do the entire work of peroxidation, but only the superoxidation or passage from PbO to PbO_2) of the protoxide formed upon the positive plate by an anterior discharge.

together with names of urban stations carried out on that system by the tenderer or others. Tenders are to be sent in to the Maire by October 2nd, and the accepted offer will be subject to the approval of the Conseil Communal, the Ministère de l'Interieur, and the legislative chambers.

ELECTRICITY IN DENTISTRY.*

The annual meetings of the New Jersey State Dental Society, and that of the American Dental Association, which were recently held at Asbury Park, were, according to the New York *Electrical Engineer*, of special interest from the fact that in the papers and exhibits evidence was afforded that the province of electricity in dentistry is rapidly increasing.

Dr. William L. Puffer, assistant professor of electrical engineering at the Massachusetts Institute of Technology, read a valuable paper on "The Electrical Principles Applicable to Dentistry"; and Mr. A. E. Woolf gave a paper on the general utilisation of his system for the electrolytic decomposition of a chloride solution. This paper told of what had been accomplished by the system, its application to the treatment of germs and diseases caused by germs; and the difference in the action of coagulants on organic matter and lower forms of germ life. Illustrations were given on the screen of the difference in the action of various disinfectants and the decomposing power of Mr. Woolf's electrozone.

An interesting electrical demonstration was made by Dr. Charles A. Meeker, of Newark, N.J. Dr. Meeker bleached several teeth at once in different chairs by cataphoresis. Pyrozone was used in conjunction with an "adapter," using 110 volts.

Dr. Meeker explained that in order to accomplish the bleaching of several teeth of different patients at the same time, it is positively necessary that the teeth so presented should be free from loose decay pulps, and without nickel, amalgam, or plastic cements.

Dr. Henry W. Gillette's paper on "Electro-Therapeutics of Obtunding Sensitive Dentine," was one of the most valuable communications of the convention.

Prominent among the exhibits was that of the Edison Manufacturing Company, who showed a compact and workmanlike dental plant. The exhibit, which was supervised by Mr. H. H. Shrope, consisted of a suspended dental motor, running from eight cells of Edison-Lalande battery of 500 ampère hour capacity, and 5½ volts. It is estimated that this cell will last the dentist, with a fair average amount of work, from nine months to a year. The motor reverses, and by means of a foot switch, can be made to stop instantly. As showing the capability of the motor, it is claimed that it can develop enough power to break the shaft. On the same circuit is worked a noiseless sick room fan, dentists' mallets, and miniature lamps for translumination. The exhibit included the Kennelly adapter, for use with the 110-volt Edison street circuit. This is a very beautiful instrument. It has a rheostat of German silver wire, 80 windings to the inch. It can be used for galvanic, pulsatory galvanic, and the different kinds of faradic current. One of its special features is the Kennelly ampèremeter, which has been recommended by the American Electro-Therapeutic Society at its last three annual meetings, as the best instrument for the physician. The Kennelly step-down transformer was also on exhibition. This is a compact device for using the alternating current for cautery work, miniature lamps, and for translumination. The step-down is from either 52 or 104 volts, to 4 volts, and about 18 ampères. The Edison family and physician's faradic batteries, the cells of which give constant current, with no action of the cell except when the switch is turned, were also shown.

The W. J. Davis Electric Company, of Pittsfield, Mass., showed an alternating current motor for dental purposes, with rheostat for starting and reversing. The motor was suspended on a flexible cable, and connected direct to the armature shaft. The starting and stopping treadle being placed on the floor. The Custer electric furnace for dental work made an interesting exhibit. The Dental Protective Supply Company, of Chicago, used a Lundell motor for driving its wall bracket connecting engine.

The exhibit of the Electro-Therapeutic Company, of New York, was conspicuous beyond the general excellence of construction apparent, from the fact that it contained a large number of novelties. Most of these are due to the ingenuity of Mr. G. M. Wheeler, the electrician of the company. The noiseless reversible motor, with instantaneous magnetic stopping attachment for operating dental engines attracted much attention. The disagreeable humming sound attending the action of some motors was entirely absent. Other points in its favour are its steady power at all speeds, reversible and instantaneous stopping attachment. The action of the motor is controlled by a new treadle connecter. This is usually placed on the floor at the base of the operating chair, connections of flexible cord allowing its movement around the chair. By the action of the operator's foot on the treadle connecter the motor is run right-handed, left-handed, or instantly stopped. When started, the motor continues running until the heel of the connecter is pressed. This arrangement allows the operator to remove his foot from the treadle connecter and working from any position, to concentrate his attention on the work in the patient's mouth. The speed of the motor is varied by means of a rheostat provided with a switch arm sliding under 10 contact pieces, giving as many variations in motor speed. As the motor was equipped with a three-sized pulley, the number of variations ran from 300 to 4,000 revolutions per minute. In the extension dental engine the bracket arm is made of aluminium, and its lightness created a pleasing impression. It is used for carrying the engine head of the dentist; it is 35 inches when closed, and 58 inches when extended to its full length.

The most notable feature of the Electro-Therapeutic Company's exhibit was its current adapter, for regulating and controlling the street circuit current for galvanic and faradic current application; it is specially adapted for cataphoric work. The difficulty with this current has always been in regulating the voltage, so that it could be so gradually increased as to cause no inconvenience in the mouth of the patient. This sudden abruptness of the change from one voltage to another has long been the bugbear of dentists. It consists of a nickel plated brass cylinder, 16 inches high, with a base diameter of about 6 inches. Its fibre head carries screw posts, a switch for turning on and off, and an index, which enables the operator to have always in sight the exact voltage with which he is operating. The needle which passes over the graduated scale of the index, registers up to 100 volts. The capacity of the machine is 500 milliampères, at maximum pressure of 100 volts. The gradations in current voltage are as fine as $\frac{1}{1000}$th of a volt, so that the increase is not perceptible to the patient. Speaking generally, there are two ways in which this instrument can be applied: First, locally. This application is made from a double pole electrode, having rubber cups, in which cotton saturated with the obtundent, presumably cocaine, is placed. This electrode is so made that the rubber cup fits on each side of the gum surrounding the teeth. The current traverses from one rubber cup, through the gum, to the cup on the other side of the gum. With the passage of the current, the tooth nerve is anæsthetised. The tooth is then ready for extraction, or excavation, as the case may be. It is in the starting of the current that the peculiar advantage of the current adapter enters. It is started from zero, and run up so gradually to, say, $\frac{1}{500}$th of a volt, that the patient does not know it is being applied. It is then raised, in waves instead of steps, to $\frac{1}{100}$th, $\frac{1}{50}$th, 1 volt, up to, say, 12 volts, giving the average maximum current. By the time the patient has thoroughly realised that the current is doing work, the work is over. This period may be from one to five minutes, according to the size of the electrode, and the temperament of the patient. The resistance of some persons to the flow of the electric current is remarkable, as doctors who are employed to watch the effect of the lethal shock at electrocutions, can testify.

The second application of the instrument is as follows: A needle-holder electrode carries a platinum needle; this electrode, used as a positive pole, is applied to cotton, saturated with cocaine, with which the cavity of the tooth is filled. The negative electrode, which is the common sponge, is held at the point of the jaw on the side of the face on which is the tooth being operated upon. When the current is turned on it traverses from the needle electrode through the saturated cotton, through the dentine and apex of the tooth, and to the outer surface of the cheek, where the negative electrode is applied. These are the two principal methods in which it has been found feasible to apply this new and humane process, to the description of which and its possibilities Dr. H. W. Gillette devoted the whole of his able paper.

The new cataphoresis in dental work includes the application of pyrozone for the bleaching of teeth. This is done in the same manner as the deadening just described, with this difference, that instead of an anæsthetic, pyrozone, a commercial form of hydrogen dioxide, which has powerful bleaching qualities, is used. An important device in this exhibit was the Freeman electric hot air syringe, a description of which was embodied in a paper by its inventor, Dr. S. Freeman, of New York, on "Compressed Air Apparatus in Mechanical and Operative Dentistry." This syringe is used with either compressor tank or a hand bulb, which the operator can work himself. The heating of the air is effected electrically. About half way down the syringe, within touch of the thumb, is a switch, for starting and regulating the current, which passes through a resistance attached to the syringe. An intense heat can be secured in this way; 600° F. have already been measured; and it is claimed that 1,000° can be reached, if necessary. The syringe is used for anæsthetising, disinfecting, or bleaching the teeth. The tooth contains about 10 per cent. of water, and it has been demonstrated that when this water is removed, the normal tooth function of transmitting impressions is impaired. Such dessication is usually accomplished by heat, cold, or chemicals: Dr. Freeman finds that heat is the best. In anæsthetising by this method, the root canals of the teeth are first dried by the stream of electrically heated air, and then the material is sprayed into the tooth, or forced through the tissues at a high pressure. In the bleaching of teeth, the required conditions for the operation can be produced in one-half the usual time by the application of hot air at a high pressure, which rapidly evaporates the pyrozone, and forces it into the tubuli.

In this exhibit the Phillips electric headlight, for direct illumination, was shown. Like the ordinary surgeon's headlight, it is fitted to the head with a spring clamp; but it has, in addition, an adjustable lens, which brings the light to a focus, or diffuses it, at the will of the operator. It also has a universal joint, which throws the light at any angle, and greatly increases its efficiency. A special transformer was exhibited, made on the same principle as the ordinary transformer; but whereas the ordinary transformer is built, say, for 1,000 volts, and steps down to 50 or 100, the Wheeler device takes in the current at 52 or 104 volts, and transforms it to from 2 to 8 volts. It is specially used for cautery work, small mouth lamps, and for general faradisation. Mouth lamps, for examination and translumination of the antrum, batteries, fan motors, electrodes, and general supplies for surgical and dental work, made up an exhibit of exceptional merit.

The convention was a great success, and the energy and administrative ability of the officers of the New Jersey Society were very much in evidence. Dr. Charles A. Meeker, its secretary, provided an admirable programme pamphlet for the guidance of the members, and Dr. Harvey Iredell, of New Brunswick, of the executive committee, earned the gratitude of all the exhibitors by his indefatigable efforts in their behalf.

* Convention of the New Jersey State Dental Society, and the American Dental Association at Asbury Park.

AUSTRALIAN ELECTRICAL NEWS.

[FROM OUR OWN CORRESPONDENT.]

The tenders for the Naval Station at Garden Island, Sydney, have just been announced as follows:—

	£	s.	d.
Brush Electrical Engineering Company	4,250	0	0
Messrs. Edge & Edge...	4,386	0	0
R. Thompson	4,601	3	0
Morris Brothers	4,675	0	0
Standard Electric Company	4,935	0	0
" " " (alternative)	4,683	0	0
" " " "	4,564	0	0
" " " "	4,351	0	0
Messrs. Siemens Brothers & Company	5,189	0	0
The Crompton Electric Supply Company ...	5,800	0	0
Messrs. Gibson, Battle & Co.	6,433	0	0
Messrs. H. H. Kingsbury & Co.	6,975	0	0

No tender has as yet been accepted.

The specification provides for three combined high-speed simple engines and shunt-wound dynamos, each to develop 200 ampères at 110 volts, with a boiler pressure of 80 pounds. Combined commercial efficiency at full load to be not less than 84 per cent., and at half load not less than 70 per cent. The engines to g vern within 1½ per cent. between full load and no load. The temperature of armatures at full load during a continuous run of six hours must not rise more than 60° Fahr. above that of the engine room.

The contractor to provide all necessary steam traps, pipes, and stop valves, and connect the engines to the boilers in such a manner that a joint may blow or a section burst in any part of the steam pipe without interfering with the supply of steam from any one boiler to any one engine. The dynamos may be of either drum or ring type of armature, but, in either case, the armatures must be wound in such a manner that any one bar or coil may be removed and replaced without disturbing the remainder. All parts of engines or dynamos must be completely interchangeable. Spare parts to be provided for each engine, also one spare armature and half-coupling to fit any dynamo, tachometer, steam-gauges, indicators, &c. The main switchboard to be of 1½-inch marble set in massive frame of colonial rosewood, to be fixed independent of wall, to contain the following appliances: Main single-pole switch and magnetic cut-out for each dynamo, connecting to bus bars; rheostat and ten-way switch (combined) for regulating shunt of each dynamo; D.P. fuse and D.P. switch for each of the four pairs of distributing mains connected to bus bars; ampèremeter for each dynamo to read from 10 to 200 ampères; one large dial voltmeter to indicate from about 95 to 125 volts of wide scale with three-way switch to connect with any one dynamo, one earth detector, and one 8-day timepiece. The installation consists of 24 arcs and 840 incandescents of 16 C P. (or their equivalent) on four circuits as follows: No. 1. From switchboard to centre of front of naval and victualling stores and thence upwards to each floor. Total 255 16-C.P. No. 2 To include engine-house for sheerlegs, barracks, boathouse, and sail-lofts, closets and latrines. Total equal to 155 16-C.P. and 5 arcs. No. 3. To include factory and workshop, saw-mill and stores. Total equal to 217 16-C P. and 13 arcs. No. 4. Officers' offices, carpenter's shop, offices, two cottages and five houses, signal station, inflammable store and dynamo room. Total equal to 213 16-C.P. and 6 arcs. The four main distributing cables from switchboard may be carried on insulators along the walls inside main buildings, without wood-casing, provided they are safe from injury. All branches must be in approved wood casing. All external wires to be underground, except where otherwise directed. The insulation covering of all wires and cables for interior work must be of aproved quality, and not less than 300 megohms per mile, and for external and underground work not less than 600 megohms per mile: the latter to be sheathed in lead with external armour braiding and compounding. At each end of all underground cables, which must be brought into the buildings, there must be a connection box of suitable form for testing purposes. The arc lamps to be arranged two in series, with suitable rheostat and switch for each pair. Double-pole cut-outs to be provided at every branch and fitting.

All arc lamps to be of a well known high class make for a current of 10 ampères, fitted for 11 mm. lower and 13 mm. upper carbons, to burn for 32 hours or thereabout, without attention; to be complete in every respect with wire-globe, spark catcher, and, for all interior lighting, white enamelled iron reflectors, 6 feet diameter, the outer edge of the reflector to be normally in a plane with the arc or slightly below it; to be fitted with self-coiling lowering tackle. Arc lamps for outside are to be on iron bark poles, about 32 feet above ground level and 7 feet below. The poles to be squared to not less than 10 inches at ground level, octagon for 8 feet above, and round tapered from 10 inches to 8 inches diameter for remaining length, &c. A pole worked and finished in a similar manner to the above, but 8 inches by 8 inches at the butt, 18 feet high above ground and 5 feet below, to be provided for the 50 C P. outdoor incandescent lamp.

There are forty clauses of conditions and a schedule of wages to be paid, as follows:—Carpenters, 8s. per day; masons, 10s; bricklayers, plasterers, boiler makers, rivetters, fitters, copper and brass workers, 9s.; shipwrights, 9s. 6d.; blacksmiths and plumbers, 8s. 6d.; painters and engine drivers, 7s. 6d.; moulders, 7s.; workmen not included in above, 6s.

A prospectus has just been issued of the Charters Towers (?) Electric Supply Company, Limited. Capital £12,500 in 25,000 shares of 10s. each; the consulting engineer (pro. tem.) being Mr. Jas. O Callender, A.I.E.E. The prospectus states that promises of support of over 1,200 lamps have already been secured. The area within which it is proposed to supply current, embraces all that within a radius of three-quarters of a mile from the Charters Towers District Hospital —this district including many of the large mines and crushing mills. The report of the consulting engineer is practically as follows:—The system best adapted for the requirements of the town is the high tension alternating current system combined with a network of low tension distributing mains, the current being generated at a pressure of 2,500 volts and transmitted at this pressure to feeding points, and there reduced to 110 volts. It is recommended that the initial plant should be capable of supplying 1,800 lamps of 16-C.P. and the cost, including buildings, boilers, steam engines, dynamos and mains, and providing for underground mains in the principal streets, is estimated at £9,500. The running cost is estimated at £2,000 per annum; assuming an average of two hours lighting per night per lamp at 1s. per B.T.U., the revenue is estimated at £3,000 per annum with 1,200 lamps connected, and £3,750 with 1,500 lamps connected.

Tenders are being called for the lighting of a new concert hall in George Street, Sydney, for 8 arc lamps and 150 incandescent lamps.

COMPOUNDING DYNAMOS FOR ARMATURE REACTION.*

By Prof. ELIHU THOMSON.

Considerable attention has recently been drawn to the subject of means for counter-balancing or preventing armature reaction in dynamo generators or motors. The valuable paper of Messrs. H. J. Ryan and Milton F. Thompson, read before the Institute at its meeting on March 20th,† called forth considerable discussion as to the actual utility or need of added devices, which undoubtedly render a machine more complex, but which can certainly be made to obliterate armature reaction or overcome its effects. The opinion which seems to prevail amongst engineers is that by taking advantage of the best principles of design, the output of our machines is not limited by armature reaction, but rather by heating, or the capacity to diffuse that heat which is sure to be produced during operation.

The writer's views are in accord with the general sentiment indicated by the discussion of the paper in question, excepting that he conceives that it may on occasion become desirable to possess a structure, either a generator or motor, in which a load which would inevitably overheat the machine if continuous, may be borne without destructive results for short periods only. The development of engineering work may, in fact, demand, occasionally, machines which would be regarded as emergency machines, to be operated with the highest possible loads for short periods. It is sometimes desirable that a dynamo be adapted to driving at different speeds while maintaining the same potential at the terminals, as in the case of direct-driven dynamos coupled with engines of different makes and speeds. Such an adaptation would require a change in the armature turns, or in the field excitation, the former demanding a reconstruction amounting to the production of a special type, while the latter, change of field strength, might involve such a weakened field at the higher speeds as would be incompatible with proper commutation. In such cases means and methods for securing proper commutation and neutralising reaction may become quite useful. The subject itself has been worked upon by the writer as far back as 1879. At first a peculiar disposition of the field coils and pole pieces was selected, unfavourable to armature reactions, and later in a patent applied for by the writer in the year 1885, the series coil of a compound-wound machine was so disposed as to add, under load, a magneto-motive force to the field in the region of armature opposition, and as a consequence to diminish somewhat the magneto-motive force of the field where the reaction of the armature was positive or assisting.

In the present paper, however, the writer desires to bring to the attention of the Institute a different type of dynamo, worked upon by him some three or more years ago, in which there is no series winding whatever, though the machine is in effect compounded, or over-compounded at will.

It is expressly to be understood at the outset that the present paper is not intended to advocate the disposition described as a desirable commercial structure, or even as one which will be likely to come into practical use on any scale. On the contrary, it is believed to be open to objections which would take it out of competition with ordinary types in which the compounding effects is secured by the series coil or load circuit wound as usual as a part of the field energising conductor.

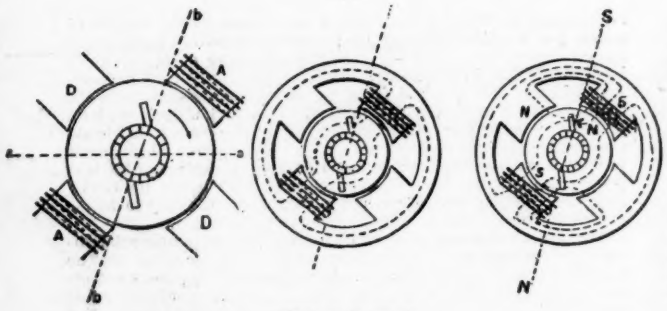
The machine is, however, interesting as bringing out forcibly the capability of the armature current to neutralise its own effects in a proper structure and maintain, or even increase, the potential at the brushes under heavy loads. In fact, the current in the armature in the type of machine herein treated, is made to react under load to magnetise a portion of the field structure which at no load is neutral or nearly so. The reaction may thus be made to give rise to a magnetic flux sufficient or more than sufficient to compensate for its effect in diminishing the flux of the other or excited portion. The result is accomplished by dividing each field pole into a portion which is left unwound and a portion which is wound and excited in shunt or separately. At no load

* Read before the American Institute of Electrical Engineers, Niagara Falls, N.Y., June 26th, 1895.

† "A Method for Preventing Armature Reaction," by Harris J. Ryan and Milton E. Thompson. New York *Electrical Review*, March 27th, April 3rd, April 10th, April 24th, May 1st, May 15th and May 22nd, 1895.

only, the wound polar portions act to generate the open circuit electromotive force. As the load is put on, the unwound or dead poles become active in consequence of a magnetic flux developed in them by the armature currents themselves, that is, in consequence of the magneto-motive force generated by the current in the winding of the armature itself. The disposition of the poles in the bi-polar structure would be represented by fig. 1, where A A are the excited poles, or wound field cores, under the fringe of which commutation is effected, while D D are the "dead" poles or sections of polar surface unenergised at no load. A dotted line *a a* may pass through the neutral or non-polar portion of the armature iron, threaded by all field lines on one side, while the lines *b b* may indicate the diameter of commutation on which the brushes rest. In such a structure by choosing the position and spread of the "dead" poles in relation to that of the wound or excited polar portions, and adjusting the magneto-motive force of the initial field relatively to the turns on the armature and the speed of driving, the effect of compounding or over-compounding may easily be obtained. The "dead" poles may be made adjustable in position so as to vary the effective magneto-motive force of the armature upon them and various changes in relations of the parts are conceivable.

In figs. 2 and 3, an attempt has been made to represent the magnetic flux under no load and under load, respectively. In fig. 2 the flux in the air gap between the excited poles A A and the armature may be considered as of uniform density, except at the edges, while in fig. 3 it is, under the same poles, somewhat diminished towards the diameter of commutation. In fig. 2 the dead poles are without flux across the air gap, while in fig. 3 the density increases from one edge to the other in the direction of rotation.



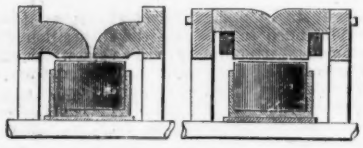
FIGS. 1, 2 AND 3.

The dynamo was constructed in accordance with the principle under discussion. It is multipolar, having four wound poles and four dead poles alternating in position around the armature. The latter is of standard iron projection type, being, in fact, identical in construction and dimensions with the armatures used about three years ago in regular four-pole dynamos of the marine type of the Thomson-Houston Electric Company.

The principal data of the armature construction are as follows:

Diameter over all	17	inches.
Length (laminations)	8	"
Radial depth of laminations	4	"
Number of projections	87	
Width of slots	·34	inch.
Depth of slots	·75	"

The armature is series drum-wound and has two conductors in each slot. The commutator has 87 segments. The new field system was constructed of two rings of cast open hearth steel having heavy lugs, four in number, projecting laterally from each ring on one side and forming the dead poles when assembled in the machine. Separate castings for carrying the field coils and constituting the active poles were made, wound and bolted between the two ring castings of the



FIGS. 5 AND 6.

field. The arrangement will be understood at a glance from an inspection of figs. 5 and 6. Fig. 5 is a section of the field in a plane passing through the dead poles and the axis of the armature, and fig. 6 is a similar section through the active or wound poles. The wound cores have a section of three and a half inches and are of steel. The field was bored to 17½ inches, thus giving a clearance of one-eighth inch around the armature. The excited or wound poles covered each about 5 inches, the dead poles each 5½ inches, leaving spaces between wound and dead poles of about 1 and 1½ inches. The face of each dead pole is 5½ by 8 inches.

The coils on the active poles can be connected in shunt to the armature terminals with a variable rheostat in the branch, or separately excited as desired. It was found for the purpose of test that the latter arrangement was most satisfactory as the exciting current could then be adjusted to any given value and would remain undisturbed by variations in the potential difference between the brushes or terminals of the machine.

Fig. 7 shows the relation of volts at the terminals to varying exciting current at no load (full line) and at 30 ampères load (dotted line) with a speed of 800 revolutions per minute. It will be noted that the load has caused an increase of voltage particularly at the relatively higher excitations. The normal current of full load for the armature as constructed and used in the regular multipolar field was 140 ampères, and it was found that as the load was increased steadily during a run, the potential was not only maintained, but increased with each increment of load, thus showing an over-compounding

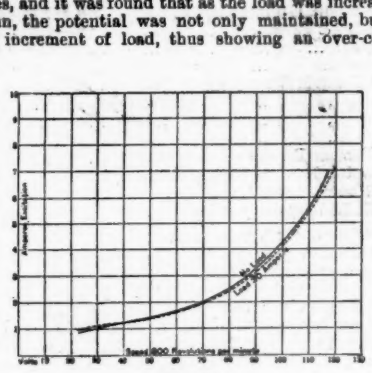


FIG. 7.

effect. This effect was less marked when the initial excitation was weak; as when less than three ampères traversed the field coils. The over-compounding under load was, of course, still more increased when the field coils were connected in shunt to the armature. Thus, at a little over 750 revolutions per minute with an exciting current of four ampères, the open circuit volts were 84, rising to 104 when a load of 130 ampères was put on with an increase of the exciting current to 4·8 ampères.

It was noticed that on any considerable increase of load being made the potential rose, in some cases, as much as five or six volts above the point at which it would remain, or which it would reach after a short interval. Similarly, it was found that the sudden taking off of load caused a temporary fall below the stable voltage under the new or diminished load conditions. This curious effect was traced to the difference of time between that needed to build up or cut down the flux in the dead poles, as compared with that required to cut down or build up the excited poles, which, being wound with wire, were naturally more sluggish under the conditions of use. Currents would be induced in the coils under each change of flux, which change itself would thereby be rendered more gradual. The dead poles being unwound could respond more rapidly. Any increase of load would, of course, tend to break down the wound poles and to increase the flux in the dead or unwound poles and the taking off of load would have the opposite effect.

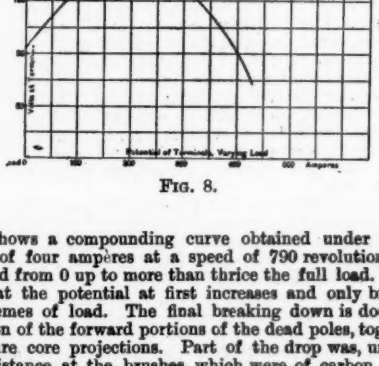


FIG. 8.

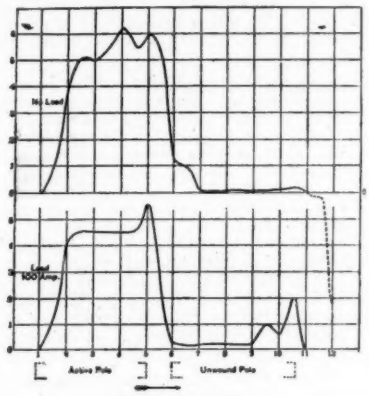
Fig. 8 shows a compounding curve obtained under a constant excitation of four ampères at a speed of 790 revolutions, the load being varied from 0 up to more than thrice the full load. It will be noticed that the potential at first increases and only breaks down under extremes of load. The final breaking down is doubtless due to saturation of the forward portions of the dead poles, together with the armature core projections. Part of the drop was, undoubtedly due to resistance at the brushes, which were of carbon, and by no means fitted to conduct off such heavy currents. Taking this drop and the drop over the armature conductor itself, it is not surprising that at the high loads the potential should fall off.

A horizontal plotting of the potentials, generated in the armature coils under no load obtained by the two brush method of Dr. S. P. Thompson, is given in fig. 9, the relative positions of the wound and "dead poles" being marked in dotted lines and the arrow indicating the direction of movement of the armature relatively thereto.

Fig. 10 gives the same plotting under a load of 100 ampères and accentuates the effect of the armature reaction in magnetising the dead poles. The curves are only approximate indications owing to the fact that the number of points at which readings were taken was less than was desirable, and because in some cases it was difficult to maintain all conditions unchanged, particularly with the very heavy loads.

Figs. 11 and 12 show a similar plotting for abnormal or extreme loads. The former shows how completely the wound pole has been broken down by armature reaction, and how the unwound poles have now become the chief working field poles, or, rather, how the armature winding itself has furnished the field for its own cutting. A calculation of the flux density at the forward edge of the unwound pole shows that the magnetisation has risen to saturation. The other parts of the pole are shown to be susceptible of increase of flux, but their relation to the armature is far less favourable for its generation.

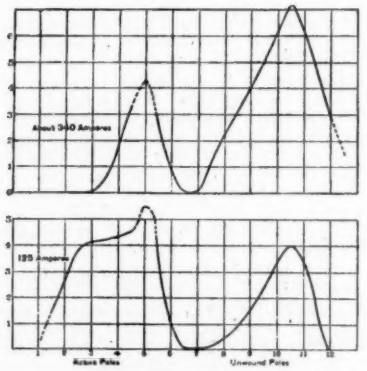
The machine described is probably chiefly interesting from a theoretical aspect. Still it shows clearly that so far as the effect of the series field on compound wound machines is concerned, the electrical engineer has other resources at his command giving similar results. It cannot be doubted also that the design of armature and field might be considerably improved with special regard for the particular feature of compounding. A feature of the machine which developed itself when carbon brushes were used, was that even at heavy loads the brushes could be set back from their maximum position, or true diameter of commutation in this case, and that the



Figs. 9 and 10.

movement was attended with little, if any increase of spark, while the potential steadily went down. It was thus easily possible to adjust the potential by a backword movement of the brushes in the space between the unwound and wound poles, while the slight sparking under the carbon brushes was not increased thereby. The writer has never noticed this effect in so pronounced a degree in any other structures, but thinks that it may not be peculiar to this machine.

A further interesting consideration is the effect of dispensing with the wound poles altogether, and either neglecting to employ any reversing or commutating field while maintaining the brushes near the forward edge of the field poles which now remain, namely, the unwound poles, or employing commutating arrangements similar to those used by Mr. Sayers, that is returning the leads through slots in the armature under the strong induction of the forward edge of the pole as the armature leaves it. In such a case it would appear from theoretical considerations that the machine should, if it possessed



Figs. 11 and 12.

any permanent magnetism, excite itself as a series dynamo entirely without any winding on the field and solely by the action of the armature winding itself. This fact was, I believe, first pointed out by Drs. J. and E. Hopkinson.

In conclusion, it may be stated that tests of the machine used to generate single-phase and three-phase alternating currents in its armature winding were made by dispensing with the commutator and substituting rings and connections common in such cases. The results indicated a substantially similar effect of compounding, but to a less degree, owing no doubt to the fact that the phase of the electromotive force generated by the wound pole flux would not coincide with that due to reaction on the dead poles, since the position of the poles with relation to any portion of the moving wire is different at the same instant.

NEW PATENTS—1895.

15,126. "An improvement in secondary batteries." W. H. Willatt. Dated August 12th.

15,134. "Improvements in apparatus for covering electrical and other wires." C. W. Washington. Dated August 12th.

15,166. "Improvements in electrophores applicable as electric lighters." J. H. Peletan and E. Christophe. Dated August 12th. [Date applied for under Patents, &c, Act, 1883, Sec. 103, February 13th, 1895, being date of application in France.]

15,174. "Improvements in single phase and multiphase alternate current motors." L. B. Atkinson. Dated August 12th.

15,178. "Improvements in electric arc lamps." E. J. Piper. Dated August 13th.

15,215. "Improvements in and pertaining to telegraphic and other printing apparatus." C. L. Buckingham. Dated August 13th. (*Complete*)

15,216. "Improvements in electric lighting attachments for gas burners." F. A. Webb. Dated August 13th. (*Complete.*)

15,225. "Improvements in electric brakes." J. Devonshire. (Communicated by W. B. Potter, United States.) Dated August 13th. (*Complete.*)

15,259. "Improvements in and connected with dynamo-electric machinery." M. S. Pickstone. Dated August 14th.

15,260. "Improvements in electro-magnetic separators." F. G. Robinson. Dated August 14th.

15,276. "Improvements in self-recording electric meters." E. P. Allam. Dated August 14th.

15,288. "Improvements in electric clocks." H. H. Lake. (Communicated by Société Anonyme La Précision, Belgium.) Dated August 14th.

15,292. "Improvements in galvanic batteries." H. Tipping and J. B. Hamond. Dated August 14th.

15,295. "Improvements in the manufacture of illuminating bodies for use in electric lighting." E. J. Constan and L. Gasten. Dated August 14th.

15,296. "Improvements in stamp batteries." C. Raleigh. Dated August 14th.

15,301. "Improvements in electric exploders." H. V. Keeson. Dated August 14th.

15,338. "Improvements in electric arc lamps." R. H. Barnett. Dated August 15th.

15,343. "Improvements in couplings or joints for the sheathing of electrical conductors." H. Hirst. Dated August 15th.

15,363. "Improvements in electrical distribution." C. E. Spagnoletti. Dated August 15th.

15,365. "Improvements in and relating to electric switches." W. H. Dingle and J. M. Urquhart. Dated August 15th. (*Complete.*)

15,369. "Improvements in secondary or storage batteries." J. B. Torres. Dated August 15th.

15,371. "Improvements in and connected with primary batteries." W. Rowbotham. Dated August 15th.

15,431. "Improved electric apparatus for striking bells and the like, or giving signals." D. Mathieu. Dated August 16th.

15,432. "Improvements in or relating to batteries." D. Mathieu. Dated August 16th.

15,433. "Improved electric apparatus for striking bells and the like, or giving signals." D. Mathieu. Dated August 16th.

15,442. "Improved means for supporting or suspending electroliers and the like, and for facilitating the raising and lowering of the same." H. Faraday. Dated August 16th.

15,445. "Improvements in step by step printing telegraphs." W. S. Steljes. Dated August 16th.

15,450. "Improvements in electric telegraphs." S. Roos, F. Luraschi and E. Luraschi. Dated August 16th.

15,461. "Improvements in or relating to telephone receivers." S. H. Snowden. Dated August 16th.

15,470. "Improvements in asynchronous electrical machines." C. D. Abel. (Communicated by La Société Anonyme pour la transmission de la force par l'Electricité, France.) Dated August 16th.

15,471. "Apparatus for converting alternating electrical currents into continuous currents." G. Bamberg. Dated August 16th.

15,511. "An improved hand-feed projector arc lamp." J. Brockie. Dated August 17th.

15,513. "Automatic regulator for dynamo-electric machines supplying electric motors." A. Donay. Dated August 17th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1894.

13,160. "Improvements in the manufacture of electric cables." G. G. M. Hardingham. (A communication from the firm of Felten and Guilleaume, of Mülheim-on-the-Rhine.) Dated July 6th. Grated or ground vegetable fibre (such as cellulose, cork, tan and the like) or other suitable fibre or bark is employed for insulating the conductor. The fibre may be in a natural state, or may be saturated with an insulating substance. About the insulation, for the purpose of retaining same in position, is laid or formed a braiding or tubular covering. 3 claims.

13,549. "Improvements in apparatus for working electric tramways by means of underground cables." C. Anderson. Dated July 13th. Relates to the working of electric tramways worked by means of underground cables, and making connection with the car above by means of rising pegs or bolts, and consists of an alternative method of actuating such pegs or bolts to that described in specification No. 14,647, July 31st, 1893, for improvements in apparatus for working electric tramways by means of underground cables. 1 claim.

13,550. "Improvements in apparatus for working electric tramways." C. Anderson. Dated July 13th. Consists in supplementing the motors carried by the cars by the use of cable haulage, that is to say, by the use of underground travelling cables placed under the roadway in those places where additional power is required. 2 claims.

13,594. "Improvements relating to the insulation of wires for electric heating apparatus." H. Helberger. Dated July 13th. The improved insulation is made or consists of beads of glass, enamel, porcelain, or the like, strung on the wires to be used. The bead-covered wires thus obtained are wound or passed around the body to be heated, so that on passage of an electric current the respective object will become heated. 1 claim.

13,700. "Improvements in telephone switchboard mechanism." J. E. Kingsbury. (A communication from the Western Electric Company of Chicago.) Dated July 16th. Relates more particularly to the keys or switching mechanism and circuit connections appropriate thereto, furnished the operator for connecting her telephone with the plug circuit and for calling subscribers, its objects being to reduce the number of manipulations of keys required in making connection between subscribers, and to construct a compact and easily accessible form of key. 9 claims.

13,728. "A combined pole and lamp-post for supporting overhead wires or cables for electric tramways or railways, telegraph, telephone and other wires or cables." A. Dickinson. Dated July 17th. Consists of a metal pole with a lamp frame formed therein at a suitable height from the ground; upon the upper portion of the pole above the lamp frame may be fixed to arms, or by other means, wires or cables overhead for supplying electricity for electric tramways, railways, telephones, telegraphs, or other purposes. 1 claim.

14,847. "Improvements in electric storage or secondary batteries." J. E. Liardet. Dated August 2nd. Claims:—1. In a secondary battery making the positive poles or elements of an outer casing of lead, coated internally and externally with peroxide of lead, the said casing being filled with shot, granulated lead, or lead chippings or filings, well mixed up with peroxide of lead, substantially as described. 2. The improvements in secondary batteries substantially as described and represented on the drawings.

15,065. "Apparatus for making electrical contact by passage of a railway train." E. Tyer. Dated August 7th. Relates to the construction of trigger apparatus arranged to operate in conjunction with a railway signal or set of points in such a manner that no contact can be made by it unless the signal or points be in a certain position, and that when a contact is made by the passage of a train, depressing the trigger, the depression and the contact are maintained until the position of the signal or points is altered. 1 claim.

16,878. "Improvements in way-bars for phonographs or similar speaking machines." W. Lacey and A. Lomax. Dated September 5th. Has reference to a new and improved form and arrangement of the tubular way-bars or gallery to which the way-tubes are attached of a phonograph or similar-speaking apparatus. 1 claim.

19,121. "Improvement in electric arc lamps." J. E. Woolverton. Dated October 9th. The present improvements are made with reference to feeding the carbon with uniformity towards each other by gravity, such carbons coming together in the form of an inverted pyramid, there being two pairs of carbons, or one pair of carbons connected together and a single carbon, and one pair of carbons, or one carbon, receives a motion from an electro-magnet so as to draw the arc. By this arrangement there is no shadow cast below the lamp, as usual in arc lamps, because the light is at the apex of the inverted pyramid. 11 claims.

22,965A. "Improvements in the method of and apparatus for electrically heating metal or other conducting bodies." W. P. Thompson. (A communication by C. L. Coffin, of Detroit.) Dated November 27th. Consists in connecting a body to be heated with one terminal of a source of electric energy, and then bringing said body in circuit with a liquid electrode connected with the other terminal of said source of electric energy, the solid electrode being first heated to about the boiling point of water before bringing it in circuit. 4 claims.

24,873. "Improvements in telephones." W. P. Thompson. (A communication by The Actien-Gesellschaft für Fernsprechpatente, of Berlin.) Dated December 21st. The improved system, which forms the object of this invention, principally consists in uniting into one, both the receiver and the induction coil. 3 claims.

1895.

56. "Improved electrical cut-out." Siemens Bros. & Co., Ltd. (Communicated from abroad by Messrs. Siemens & Halske, of Berlin.) Dated January 1st. Claim:—A safety cut-out for electric circuits, consisting of a fusible metal strip or wire which, with the exception of the part to be fused by excessive current, is imbedded in a solid dielectric that is easily melted by the heat produced from such current, so as at once to extinguish the electric arc formed between the ends of the fused strip or wire.

157. "Improvements relating to telephone call stations with automatic charge or fee receiving devices." C. A. Jensen. (A communication from abroad by N Jacobsen, of Christiania.) Dated January 2nd. This invention is of such a nature, that the apparatus returns to its normal position when, by means of a common call device, the usual alternating current from the central station is sent through the apparatus. Thus the closing or final signal from the subscriber called on will bring the automatic fee box to its normal position. 1 claim.

348. "Improvements in rectifiers for electrical currents." W. B. Close. Dated January 5th. Consists essentially of a motor run from an independent source, a dynamo, the fields of which are run from a shunt circuit from the alternating current wires, a commutator of peculiar construction having its brushes connected to the main alternating current wires and brushes for leading off the constant current, the armatures of the motor and dynamo, and the peculiarly constructed commutator being all secured to a common shaft, and the different parts being otherwise constructed as more particularly explained. 6 claims.

358. "Improvements in electrodes for secondary batteries." J. Wershoven. Dated January 5th. Consists in providing the surface of the plates between the ribs or bars of the support with a metallic protective covering, which is firmly connected to the said ribs or bars. 4 claims.

497. "Improvements in and relating to electric railways." J. C. Love. Dated January 8th. Relates to improvements in that class of electric railways or tramways in which the line wires or conductors, for supplying current to the electric motor on the vehicle, extend through an underground conduit having a slot at the surface of the roadway, through which slot extends the travelling contact device on the car, by which the current is taken from the wires. The invention embraces improvements in the construction of the slotted conduit itself, in means for supporting the electric conductors therein, in devices for keeping the conductors tightly stretched and adjusting the tension of the same, in the travelling contact device, which is carried by the car, and which runs in contact with the conducting wires within the conduit, for taking the current from the same, and in an auxiliary conduit adapted for use in connection with the main conduit for carrying supply or feeder wires, or other purposes. 41 claims.

545. "Improvements in electrical switches." C. M. Dorman and R. A. Smith. Dated January 9th. Consists in the combination of the type of controlling spring described in Specification 13,410, 1894, with the various new types of switch. 1 claim.

1,000. "Improvements in and relating to conduit electric railways." W. T. Dulany, Jun., and O. F. Shaw. Dated January 15th. The chief objects of this invention are to provide, in connection with two conductors or trolley wires placed within a conduit and insulated therefrom, a trolley standard containing, within the wearing plates, flat metal plate conductors made in series, with fuse blocks or cut-outs above, and also under the points of contact of the standard, with the slot of the conduit, so that if the wearing plate on one side of the standard becomes cut or worn through while a car carrying the standard makes one of its trips, the plate conductor on the opposite side will continue to transmit power to the motor of said car. 18 claims.

1,088. "An improvement in safety fuses for high tension electric currents." Siemens Bros. & Co., Ltd., and F. Hird. Dated January 16th. Consists of a bridge piece, which may be of circular, rectangular, or polygon section, made of incombustible insulating material such as slate, pipe clay, ceramic material, or the like, attached to metal terminals, and having through it from end to end a central hole, and in or near its middle an open slot. The fuse wire is passed through holes in the terminals and through the central hole of the piece in which it is secured by plaster of Paris or other suitable cement. 1 claim.

1,164. "Improvements in automatic telegraph apparatus. A. Damaskinos. Dated January 17th. Has for its object improvements in typographic telegraphic apparatus, by which are attained the following advantages as compared with such apparatus as ordinarily heretofore used. 1. Greater rapidity than has heretofore been obtained. 2. The avoidance of all mistakes in the composition of words, as each character has written upon it the corresponding letter. 3. A manipulation which requires no special knowledge on the part of the operator or of the receiver, who need only be able to read the letters representing the signs. 4 claims.

1,446. "Improvements in galvanic batteries." C. B. Schoenmehl and C. M. Platt. Dated January 22nd. The carbon pole of the battery is integral with the cover, and consists of a circular series of carbons, which may be of any preferred formation, said carbons being arranged so as to be exposed upon all sides to the fluid in the jar, and not exposing the metallic connection between them. The metal connections within the cover and between the carbons are not exposed to the interior of the jar, or to the top of the cover, thus protecting it from the fluid, gases, &c. 3 claims.

1,526. "Underground conduit for electric roads." E. A. Mathers. Dated January 22nd. The chief of the invention is to provide an improved conduit, which may be located entirely below the surface of the street or ground, within which may be arranged an electric conductor or conductors, through which the current may be supplied to the motors by means of a suitable trolley carried by the car, and passing into such conduit from above, and being provided with suitable devices to make contact with the conductor or conductors in said conduit. 7 claims.

1,546. "An electric switch." F. Wright and E. J. Piper. Dated January 23rd. Relates to the construction of an electric switch or apparatus for opening and closing an electric circuit in such a manner that the action is rapid and certain.